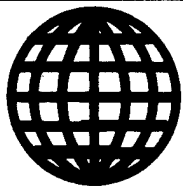


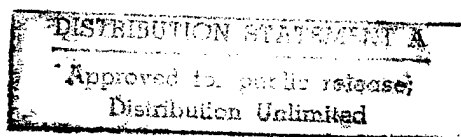
JPRS-TND-90-010
12 JUNE 1990



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JPRS Report

Nuclear Developments



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Nuclear Developments

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SOUTH AFRICA

Future Nuclear Plant Sites Examined

51000009A Johannesburg *FINANCIAL MAIL*
in English (*ENERGY Supplement*) 13 Apr 90 pp 8-12

[Text] SA's only nuclear power station is operating at Koeberg. Despite alarms sounded by the anti-nuclear movement, it has run without hitches and with very little down-time.

The question is: Where and when will a second nuclear installation be built?

The FM talked to Peter Spencer, corporate consultant in nuclear engineering at Eskom, and Peter Wakefield, deputy engineering manager, Eskom, with special responsibilities for nuclear energy.

Spencer explains he was told to investigate how Eskom's engineers would go about building the next nuclear power station, on the assumption the earliest date it would be required would be the year 2004. He and a small working group recently presented their report on the technologies available, the safety situation and the suppliers who might put up the proposals.

The report has indicated, first, that there is a change of attitude towards nuclear power; several countries are holding back plans. The Japanese and, perhaps, the Koreans are the only First World countries firmly going ahead with their nuclear programmes. The French, for example, have already completed their massive programme. Apart from ultimately replacing earlier nuclear plants, they have little need for further construction.

The nuclear construction industry has had to accept this situation. It is trying to position itself to come up with projects and designs it believes will be required around the end of the century.

In many countries, says Wakefield, the growth in demand for power has fallen short of the rates experienced in the Sixties and Seventies. So most are able to survive without building more generating plants. In other cases, there has been an inhibiting public reaction to the accidents at Chernobyl and Three Mile Island.

In the United States, a combination of factors has brought the process of developing new nuclear power plants to standstill.

On one hand, the opposition of anti-nuclear groups has forced electrical utilities to run the gauntlet of numerous regulatory and legal hearings. This has stretched out construction time and involved high interest charges. On the other, control boards have refused utilities an increase in tariffs to pay for the extra charges.

The result has been virtually no new nuclear power plant signed for in the United States from the mid-Seventies onwards.

SA's over-capacity was arrived at in much the same way as other industrial countries arrived at theirs: leading us into a similar trap as the Americans and Europeans.

Wakefield thinks the biggest component of this forecasting error has been the realisation that the world has not been using electricity—or energy in general—efficiently. There have been efforts in the Western world to correct that situation.

Spencer says the work of the study group has made it clear Eskom would go for a tried and tested design which would give a sound return on the investment. "We are not in the business of trying out new and wonderful ways of using nuclear fuel."

Eskom wants to stay with the mainstream of international nuclear activity, which was done at Koeberg by using a design similar to the French units, which in turn, were similar to the American units.

As for timing, says Wakefield, Eskom has taken its planning along a scenario basis. Because of SA's difficulties, one has to take an upside scenario and a more pessimistic downside projection of economic performance. And those two scenarios have given very different answers.

The upside scenarios postulate a high growth rate—ranging between 5 percent and 10 percent a year. Certainly at 10 percent, the date at which large-scale nuclear generation would be needed advances quite close in planning terms into the early part of the next century.

Wakefield's job, looking to 2000, is to be sure that Eskom and SA have a base of skilled people from which to move into the new technology. "If one has the funds, one can buy the hardware," he says. But what cannot be rapidly built up is manpower resources to manufacture, design, regulate, operate or maintain the station.

So, if we look at the year 2000 and the timing of the next nuclear unit, the aim of that project is not only to meet electricity demand. It's also to build that base from which the big change to nuclear power would sooner or later be launched.

He sees, in all the planning done by Eskom and the Atomic Energy Corp, that a progressive changeover to nuclear power would have to occur some time towards the middle of the next century. The "relative economics of nuclear versus coal" would determine the speed at which we change over.

In the early stages of a nuclear power programme, Wakefield does not see SA setting out to manufacture the full range of components required to build a nuclear power station. All we should be doing is to build that base of people capable of managing the nuclear technology involved in the building of the power stations.

Taking only the next nuclear plant in isolation, SA has already established enough nuclear fuel manufacturing capacity to meet its needs.

What would happen if France and other overseas countries refused to supply a nuclear power plant on political grounds?

Wakefield's personal view is that the cost to SA of going it alone—for a technology already more expensive than coal—would not be attractive enough. SA has substantial quantities of coal and could afford to sit out the situation for another 20 or 30 years. He thinks that is the way Eskom would go.

But Wakefield is not too pessimistic; virtually all the big suppliers of nuclear power stations are seriously short of work. They have gone through a process of amalgamation and the strangest bedfellows have come together. We see the Germans and the French discussing whether there is a possibility of supplying nuclear power stations jointly in the future.

They seriously need that work. Wakefield thinks considerable pressure would be put on politicians overseas if Eskom showed clear signs that it wanted to move forward. If the financial problems could be sorted out, the industrialists and the politicians would find ways of making it possible to supply Eskom. This belief, obviously, is fortified by recent political developments.

Spencer notes that two schools of thought are forming internationally on the question of future nuclear design philosophy.

There is a school—mainly Europeans and Japanese—which wants to refine further and develop nuclear engineering to evolve a future design based on currently operating reactors; a so-called evolutionary design.

It will be based on large units, probably of 1,000 MW-1,460 MW—a range with which the overseas designers appear to be comfortable. In fact, there are many 1,300 MW reactors already operating. The evolutionary aspect really doesn't have anything to do with size but rather with refining details of the plant and safety systems.

The second design philosophy is largely being dictated by the American market.

The U.S. utilities have been badly affected financially by the safety obsession and consequent long delays in licensing. They will not place new orders until there is a product that is clearly likely to be licensed. Nor, moreover, until the U.S. government has established a rational basis for regulating the nuclear industry. If this cannot be achieved and America has to import large quantities of oil and even coal, so be it.

The American industry's response to its past suffering, in effect, has been to say that manufacturers must come up with a revolutionary design. One that is smaller, safer, cheaper to construct and faster to commission. Most important, "it has to be able to be licensed from day one," Spencer says.

Hence the Americans have become identified as the movers for a revolutionary design.

The choice between the two philosophies is inhibiting decisions worldwide on new nuclear plants. Everyone is waiting to see the outcome, but before the middle of the Nineties, no one wants to make the move. A possible exception is Japan, which is starting to build new American designs in co-operation with U.S. companies. In so doing, the Japanese might be building up a decisive lead for the next century.

If Eskom did want to go out tomorrow to buy a nuclear power station, "we are being asked to hold it," says Spencer, because the manufacturers won't be ready with their new product lines before 1995.

Wakefield concedes that marginal improvements in existing safety levels would be introduced—largely to remove the requirement for contingency planning for mass evacuations presently insisted upon, and so to allay public anxieties. Not, emphatically, because the existing designs (such as that at Koeberg) present a meaningful level of risk. What is uncertain is whether the American approach will raise or reduce cost per installed kilowatt.

While much has not been decided yet about the engineering of this revolutionary generation of plants, it is clear they will be small. It will not be possible, economically, to build these types as 1,300 MW monsters. They are looking at plants in the range of 300 MW-600 MW a unit.

Certainly, if Eskom reaches the point where it has to freeze the design for a second nuclear plant, it will be entirely comfortable with an updated version of Koeberg.

Spencer puts it more strongly. He thinks that Eskom—for the next SA nuclear power station—would be happier going with a design that was well proven and running, rather than choosing one without a track record. Historically, prototypes and designs that are the first, second or third of the series give a far worse return on investment, "usually because they spend more time shutdown than running."

And that in itself does not augur well for a plant if it keeps having to be shut down because of safety considerations. Anyway, it looks as if the commercial proving of revolutionary designs would have been completed only by the year 2010.

Wakefield says the construction period could take from five to six years. But that would be subject to having a detailed design already carefully worked through with the preferred suppliers—with their assurance of its being licensed. And if Eskom firmed all this up before placing its order.

However, the total time stretches to 10 years if that detailed, upfront design work is taken into consideration.

Eskom is clear that, on an evolutionary design at any rate, it would require a fully detailed design and a licence clearance before it placed the main contract.

Spencer points out that Eskom can still sit on the phone until 1995, when the move would have to be made for new nuclear capacity to come in around 2004. The longer the delay in this sort of situation, the more clarity on the decision. In the waiting period before 1995, Eskom can make moves on firming up design details or design options or licensing aspects.

Spencer says it is public knowledge that Eskom has bought several sites. Some may be kept in reserve for 20-30 years.

It should not be forgotten the Koeberg site is a good one—and can readily take more units. But no firm decision on siting has been taken. The need for large quantities of cooling water and the existence of large port cities remote from the coal-fired inland plants dictates a coastal location for future nuclear plants.

'It should not be forgotten that the Koeberg site is a good one.'

Generally, the existing generation of coal-fired plants was built in the Eighties. If one accepts that they will have a 30 to 40 year life span, then their replacement is some way down the track. However, there is a link with growth in GDP.

If Eskom needs to take care of substantial growth into the next century, coupled with the generation of coal stations coming to the end of their lives, you will get "a double forcing factor" pushing SA to an alternative base. If, that is, coal is then economically unattractive, or—for environmental reasons—it is decided that there is a sufficient loading of coal stations on the atmosphere.

If technology reached the point where the next generation of coal-fired plants were to be a combined cycle design which would deal more effectively with environmental problems and also boost operating efficiency, could this have a major impact on the timing for the next nuclear plant?

Spencer says that the combined cycle time scale is comparable to the time scale of the so-called revolutionary nuclear designs.

There are no proven combined cycle plants commercially available, so there seems to be a period of at least 10-20 years for those designs to be well proven. Were the next 20 years to bring major advances in that area, it could affect the speed at which one would go towards nuclear power.

But it is important to realise coal still enjoys a powerful cost advantage over nuclear power in SA. That is likely

to remain the case "until coal exhaustion begins to stare us in the face," as Spencer puts it.

Local Manufacture of Nuclear Fuel Revealed

51000009B Cape Town CAPE TIMES in English
25 Apr 90 p 3

[Text] South Africa has scored a major breakthrough by manufacturing its own nuclear fuel.

This was announced jointly yesterday by the Atomic Energy Corporation (AEC) and Eskom, which disclosed that the locally manufactured nuclear fuel was used to load one of Koeberg's two reactors.

The fuel was manufactured at the AEC's plant at Valindaba, west of Pretoria.

Describing the development as "a tremendous breakthrough," the joint statement said the technology required was "very advanced."

It incorporated not only the enrichment of the fuel but the manufacture of the elements, "built to extremely close tolerances using highly specialised alloys."

AEC spokesman Dr. Waldo Stumpf said last night that this major advance in the nuclear field meant that South Africa was now independent of overseas supplies of nuclear fuel and that Koeberg could run independently.

Furthermore, "a very large amount of foreign exchange will be saved annually."

"An amount of about R50 million to R100 million—depending on the size of the order—will be saved per reactor a year," Dr. Stumpf said from his Pretoria home.

The fuel delivered to Koeberg now contained about 25 tons of uranium, which was equivalent to two-and-a-half-million tons of coal; 25 tons of uranium is enough fuel for one reactor for a year.

Dr. Stumpf said the Council for Nuclear Safety had to license the fuel "so exactly the same quality standards were achieved as overseas fuel."

The next step was to "optimise our fuel supply to plants which supply us with fuel, to introduce more cost effectiveness into plants and to keep on supplying Koeberg with fuel as and when required.

"We are certainly also looking at other forms of technology for making fuel that will be more cost effective."

He said more nuclear plants would be built but the decision lay with Eskom.

"We just supply the fuel. They run the plants."

China Considering Observer Status at Nonproliferation Conference

*OW0905005290 Beijing XINHUA in English
2345GMT 8 May 90*

[Text] United Nations, May 8 (XINHUA)—Chinese Ambassador Hou Zhitong reiterated today that the superpowers, which possess the largest arsenals, have a special responsibility for halting the arms race and realizing disarmament.

Speaking this morning at the 1990 session of the UN Disarmament Commission, which opened yesterday, the ambassador said the superpowers should not only substantially reduce their armaments, but also stop their qualitative arms race.

"What must be noted," he pointed out, "is that both parties have admitted recently that the target for their strategic nuclear weapons reduction has been curtailed from the original 50 percent to the present 30 percent."

"Even if they have indeed cut such weapons by half, they still own more than 90 percent of the total nuclear weapons in the world, enough to destroy mankind many times," he added.

He said the superpowers, in their negotiations up to now, have kept evading the issue of a qualitative arms race.

"While constantly upgrading their conventional armaments, they are now replenishing their already huge nuclear arsenals with a new generation of nuclear weapons of improved accuracy, penetration and mobility," which "poses a serious threat to world peace and security."

On the issues of preventing nuclear proliferation and the prohibition of nuclear test, he reiterated that "China does not advocate, encourage or engage in nuclear proliferation."

He told the commission that the Chinese Government has decided to give favorable consideration to attending, as an observer, the fourth review conference of the parties to the treaty of nonproliferation of nuclear weapons.

He reaffirmed that China is opposed to the practice of going all out for the nuclear arms race while refusing to unconditionally provide security assurance to non-nuclear-weapon states on the one hand, and imposing unreasonable restrictions on international cooperation for peaceful uses of nuclear energy in the name of preventing nuclear proliferation on the other.

As to naval armaments and disarmament, he pointed out that while negotiating to reduce nuclear and conventional armaments, the world's leading naval powers have continued their naval arms race and their rivalry in the oceans. The "gunboat policy" remains a threat to many countries.

"Naval disarmament forms an important integral part of the nuclear and conventional disarmament and should be addressed without delay," the ambassador emphasized.

He said that "since disarmament and security are issues having a direct bearing on the vital interest of all countries, all of them, big or small, strong or weak, have an equal right and are invariably entitled to participate in the discussion and settlement of these issues."

He said in conclusion that bilateral disarmament efforts and those involving a small number of countries are welcome, but they should not be used to belittle, reject or replace the global multilateral efforts.

THAILAND

Science Attache, Nuclear Cooperation With Japan *90WP0069A Bangkok THAI RAT in Thai 19 Mar 90 pp 1, 21*

[Excerpt] [passage omitted] The establishment of a Science and Technology Advisory Office in Tokyo, Japan, is a historic step for Thai scientific circles, because this is Thailand's first "science attache" office. This resulted during a trip to Japan by Mr. Prachuap Chaiyasan, the minister of science, technology, and energy. He was in Japan to attend the first conference on Technological and Nuclear Cooperation in Asia, which was held by the Japanese Nuclear Energy Committee at Tokai University on 12 and 13 March. Dr. Phichit Rattakun, the former deputy minister of science, Mr. Sanga Sapsi, the under secretary of science, and other senior government officials also attended this conference.

Mr. Prachuap Chaiyasan said that the Thai government realizes the importance of science and technology, and the cabinet has authorized the establishment of advisory offices in three cities, Tokyo, Washington, D.C., and Brussels. All of these places are important sources of data in three regions of the world.

As for why this office has been established, Mr. Prachuap said that it will serve as the country's representative in coordinating scientific and technical matters between Thailand and Japan so that things are carried out in a

satisfactory and rapid manner. It will be a progressive and modern center for collecting scientific and technical data that can be used in Thailand. It will study the advances and changes in the field of science and technology in Thailand and Japan and give advice on the purchase and exchange of technology.

Mr. Prachuap said that he will go and open the other two science and technology advisory offices, that is, the offices in Washington, D.C. and Brussels, sometime in May.

Furthermore, at the conference on cooperation in the field of nuclear energy, Mr. Prachuap Chaiyasan told the conference that Thailand is conducting research on nuclear energy for use in agriculture, medicine, and industry. Thailand is now in the process of moving its atomic reactor out of Bangkok and increasing its power so that there is sufficient power to conduct research studies.

As for atomic power plants, the Indonesian representative at the conference reported that Indonesia will have an atomic power plant within 13 years. Mr. Prachuap said that before Thailand takes any action on this, it will have to see how the Thai people feel about this, because Thailand is a democracy. However, Thailand has very advanced technology in the use of nuclear energy in the fields of medicine and food. This can also be used in conducting surveys for lignite and minerals, eradicating insects, and expanding the production of silk thread.

BRAZIL**Charges of Smuggling Nuclear Equipment Refuted****Official Denials**

90WP0074A Sao Paulo O ESTADO DE SAO PAULO
in Portuguese 19 Apr 90 p 7

[Text] Brasilia—The former chairman of the National Nuclear Energy Commission (CNEN), Rex Nazare Alves, who gave up that post 20 days ago, yesterday challenged the Carnegie Foundation for World Peace to prove that Brazil had smuggled nuclear equipment.

"Brazil has never smuggled material or equipment for its autonomous program or the program carried out in cooperation with Germany," said Rex Nazare. The former chairman is among those named by the U.S. organization, which is linked to the Democratic Party.

"The Carnegie Foundation's accusation is unfounded, and it has a duty to present specific proof to back up of that accusation," he said. Rex Nazare is alleged to have participated in the secret and illegal importation of sensitive materials for the Brazilian nuclear program.

The new CNEN chairman, Jose Luiz de Santana Carvalho, also regarded as absurd the charge made by the foundation, which has its headquarters in Washington. The foundation included Brazil in a fivefold list of countries that have allegedly smuggled sensitive materials from the industrialized countries for the sole purpose of carrying out military projects not subject in any way to international controls or safeguards.

In Santana's view, that type of accusation is part of a ploy whose main objective is to block the sale of advanced technology and equipment to developing countries such as Brazil. "It is so-called technological colonization, and it has to do with a barrier set up to prevent a country's technological progress," Santana declared. That blockade attitude is typical of the industrialized countries, he pointed out.

The CNEN's current chairman also mentioned the sale of supercomputers, which is subject to restrictions and requirements which Brazil considers offensive to its sovereignty. The sale of that type of equipment usually runs up against arguments like the one saying that computers of that size might be used for calculations in military programs.

"The allegation that Brazil is developing nuclear technology for military purposes is the explanation for those blockades," Santana said. He mentioned the USP [Sao Paulo University] and Embraer [Brazilian Aeronautics Company] as being constant victims of those restrictions. The fact is, according to Santana, that those two institutions need that equipment for basic research.

"It is because of those restrictions that Brazil is developing technologies independently, one example being nuclear technology."

The Ministry of Foreign Affairs said yesterday that it was unaware of any instance in which nuclear materials or technologies had been smuggled into Brazil. Ministry spokesman Jose Vicente Pimentel took the opportunity to emphasize that the country has commitments, adopted in its Constitution, that prohibit the use of nuclear energy for military purposes. The spokesman pointed out that the Brazilian posture and the nonexistence of a climate of competition with Argentina in the nuclear area have been clearly stated in a wide range of cooperation agreements between the two South American countries.

The Ministry of Foreign Affairs reaffirmed that the Brazilian Government continues to oppose the idea of signing the Nuclear Non-Proliferation Treaty, which Brazilian diplomats regard as a tool for freezing world power and establishing a kind of oligarchy made up of countries that may have access to nuclear technology—meaning precisely those countries that already had it when the treaty was signed in 1968.

In the view of the Ministry of Foreign Affairs, the accusations made by the U.S. institution are totally out of line with South American reality.

'Hypocrisy' Noted

90WP0074B Sao Paulo O ESTADO DE SAO PAULO
in Portuguese 19 Apr 90 p 3

[Editorial: "The Hypocrisy of Nonproliferation"]

[Text] The study sponsored by the Carnegie Foundation for International Peace concerning the control of exports of nuclear material is a brilliant piece of political hypocrisy. Unfortunately, it is destined to become a reference document that will be quoted in support of political decisions and other academic studies serving to form opinion in decisionmaking circles. It is that fact—and not the document's substantive content—which brings it out of the realm of irrelevancy, just as it is the tone of supposed moral superiority which fills it with hypocrisy. Especially since the days of the Carter administration, the nuclear nonproliferation lobby has chosen Brazil as one of its favorite targets. After all, Brazil had just signed an agreement with the FRG to acquire and transfer nuclear technology, a step unprecedented anywhere in the world and one with the potential for upsetting the international balance which the United States was interested in maintaining.

Moreover, Brazil was not—is not now, and will not be, as Minister of Foreign Affairs Francisco Rezek has just made clear—a signatory to the Nuclear Non-Proliferation Treaty (NPT), and that has been one of the main arguments brandished against the country's aspirations to acquire sensitive technology. Brazil's position—whether one agrees with it or not—is that it has not acceded to the NPT because it regards that treaty as a tool for freezing power in the hands of those who already know how to produce nuclear plants and devices and making all other nations accept a secondary status.

Since it feels that way, Brazil turns the proposition around: it favors any and all denuclearization processes except those banning the peaceful use of nuclear energy, that being the only use of the atom accepted by Brazil. That policy has been unequivocal, and it has been made a binding rule by the Constitution of 1988.

It goes without saying that the nuclear powers are not interested in letting new members into their select club. Doing so would, in fact, mean a dilution of the relative power possessed by each of them—not, as is too easily argued, an increase in the risk of nuclear conflict. That latter argument assumes that there are responsible and irresponsible nations and governments and that the responsible ones are necessarily those with the bomb. Equally arrogant is the oversimplification indulged in by all nonproliferation lobbyists when they say that there is no dividing line between technology for peaceful purposes and technology for military purposes. It is a fact that anyone capable of enriching uranium to 20 percent is technologically capable of enriching it to 98 percent, but between those two figures stand objective barriers which begin with a definition of national interest, continue with a political decision to produce a device, and end with the harrowing formulation of foreign and defense policies based on possession of that atomic weapon. A typical example of that obstacle course is India, which stopped short of the final obstacle.

The report signed by Leonard S. Specter, director of the Carnegie Foundation's Nuclear Non-Proliferation Project, is fallacious and irresponsible, especially as regards Brazil. It suffers from an inherent defect. The author based his singular conclusions solely on reports in newspapers and magazines. It is obvious that the director of the Carnegie Foundation project used secondhand or thirdhand information to bolster his prejudices and justify conclusions reached beforehand. Even when he quotes information from the FRG's intelligence service, he is forced to rely on the version published in the magazine NUCLEONICS WEEK. That kind of research, which is academically irresponsible, generally absorbs—and, unfortunately, establishes by repetition—the mistakes that may have been made in unspecialized newspapers and magazines, whether those inaccuracies be unintentional or deliberate—as seems to be the case with the report saying that at its current stage, the pilot plant in Ipero is capable of enriching uranium to 70 percent.

The prejudices and objectives of the author of the study become obvious when he calls for military and economic sanctions against countries which circumvent the ban on transferring sensitive materials and recommends stiffer controls to restrict the nuclear ambitions of Iran, Libya, and North Korea. The fact is that the author omits Israel and South Africa from that list. Those two countries have controversial policies—there are those who call them pariah countries—they are partners in nuclear research for undisguisably military purposes, and they are situated on the "threshold"—that is, they are among

the countries that either already have the bomb or can produce it in an extremely short time.

Active in the nonproliferation movements are thousands of well-intentioned people who are genuinely concerned about the threat which nuclear weapons represent to the future of humanity. The real danger, however, comes from vertical proliferation—that is, the existence of atomic arsenals now large enough to destroy the planet 20 times over, if that were possible. What one cannot do is use the argument of potential and remote dangers to prevent access by the vast majority of countries to a type of know-how and a technology which can lead their societies to progress and well-being. After all, as Guimaraes Rosa used to say, living is a very dangerous business.

Safety Concerns of Angra I Addressed

90WP0073A Rio de Janeiro MANCHETE
in Portuguese 21 Apr 90 pp 18-27

[Article by Helio Contreiras—first four paragraphs are MANCHETE introduction]

[Text] In its nine years of precarious operation—including only five in which it has operated with reasonable continuity—the Angra I plant has been a "bomb" for the country. With its steam generator condemned, it has become a threat to life and the environment and brought the debate over the Brazilian nuclear program to the surface. While measurement technicians inside the plant check the level of radioactivity, Minister of Infrastructure Ozires Silva in Brasilia says in an exclusive statement to MANCHETE that "the nuclear program has already cost the country \$8 billion, and it must say quickly what it has produced in return." As a byproduct of the problem, a visible threat—nuclear waste—is building up in the plant's storage area.

Fitted into the landscape, cylindrical Angra I and circular Angra II are the logotype of the Brazilian energy program. "Decipher me or I'll devour you" is what they seem to be saying to Brazilian society, which is only now being called on to join the debate. Coexisting unhappily at the nuclear complex are high technology and the potential risk to the community. The tranquil atmosphere of what used to be Itaorna Beach has been replaced by fear. Persistent work by the plant's technicians is the only guarantee of safety.

A concrete building at Angra I holds the sealed drums containing radioactive waste. There are 2,980 containers holding medium- and low-level waste, but that does not eliminate the waste's carcinogenic and lethal potential as far as human life is concerned. The sealed waste includes protective clothing, tools, and miscellaneous objects that have been exposed to radioactive contamination. Inside the plant, the atomic waste is awaiting the day when it will be taken to the final storage site that will soon be selected, according to authorities in the new administration.

For the first time, the Brazilian press is publishing these photos of the pool at Angra I where highly radioactive nuclear waste is stored. The water acts as shielding to isolate the radioactive material. Its surface presents risks, but the really dangerous zone is at the bottom, where the atomic waste is concentrated. The pool is 20 meters long and 7 meters wide. The vapor it emits does not—according to technicians—cause contamination problems. Like that contained in the drums, the waste stored at the bottom of the pool is waiting for a place to go.

The Angra I Nuclear Power Plant has been in operation since 1981, but because of various operating problems, it was unable to begin operating continuously until 1985, according to Diniz Alberto de Oliveira Resende, chief of the plant's Radiological and Environmental Protection Division. And it is now experiencing its first genuinely serious problem: the steam generator, which according to the contract signed with Westinghouse of the United States was supposed to be guaranteed for 40 years, will in fact have to be replaced. That equipment may turn out to have a useful life of 15 years at most. It was the head of Angra I himself, engineer Jayme Lacerda, who told MANCHETE that a total of 47 tubes in the Brazilian nuclear power plant's two steam generators have now been closed off.

"The only way to prevent the leakage of contaminated water and consequent harm to human life and the environment is to plug up the tubes," says Lacerda. Because of the problem—and despite the cost—every precaution has been taken to ensure the safety of the public.

Is the Brazilian Nuclear Program living up to the expectations of the society that was not even consulted about it when it began? Judging from statements by technical managers at Angra I as well as by a political official—Minister of Infrastructure Ozires Silva himself, who is responsible for the energy sector—the nuclear program has "sprung a leak." The minister made this unprecedented statement to MANCHETE:

"The nuclear program has already cost the country a great deal—about \$8 billion—and it must say quickly what it has produced in return. Society cannot keep on paying for this indefinitely."

Ozires Silva is in a hurry to decide the future of the Brazilian Nuclear Program. And he intends to announce it to the public. The minister wants quick and practical solutions which will be less expensive and more reliable and which will ensure results and, above all, safety.

Ozires Silva's opinion is backed by the secretary of strategic affairs in Planalto Palace, Pedro Paulo Leone Ramos, who says that Brazilian society can no longer be left out of major decisions concerning nuclear energy. He points out that beginning on 15 March of this year, the nuclear policy came under civilian control after nearly three decades of strong military influence.

"Previously, the National Nuclear Energy Commission was subordinate to the Defense Council (which was known as the National Security Council until 1988). Under the new administration, it was placed under the control of the Secretariat of Strategic Affairs, an eminently civilian body," Leone points out. The Autonomous Nuclear Program, in which the Navy participates, is subordinate to the Secretariat of Strategic Affairs, while the government-owned Furnas Electric Power Plants, Inc., which manages the energy sector, is responsible to the Ministry of Infrastructure.

Concerning participation by the Navy, which for the past three years has been jointly responsible for mastery of the uranium enrichment cycle in our country, Minister Mario Cesar Flores is talking about the matter for the first time and expressing his concern over what will be done with atomic waste, a question that has become one of the chief puzzles in programs all over the world.

He says: "Nuclear waste is a serious problem for everyone. In Ipero, where the Navy is developing the technology for a submarine reactor, waste has not yet appeared, but when it does—sometime around 1994—it will be sent to a place still to be determined by the National Nuclear Energy Commission."

Concerned to bring about the strategic improvement of the fleet, the minister of Navy does not see the construction of nuclear-powered submarines as being linked to a plan for producing an atom bomb. In his opinion, such a plan is not being considered in military circles.

The minister, who is an admiral and respected as an important strategist, concluded by saying: "It would be absolutely inconsistent with our political and strategic problems, both domestic and international, for us to think about an atom bomb now."

As analyzed by the minister of Navy, nuclear waste may soon become the first vehicle for public participation in the program. The man suggesting that possibility is chairman of the National Nuclear Energy Commission under the Collor administration, Jose Luiz de Santana Carvalho, who is also a member of the SPBC (Brazilian Society for the Advancement of Science), an institution which, although unable to break down resistance to the idea, tried throughout the period of arbitrary government, in which the program was operated as a "closed circuit" (that is, the past 27 years), to be a channel of communication between the public and the decision-making power.

Jose Luiz announced: "We will soon have important decisions in which public participation will be essential. I am referring to the criteria for selecting the sites where nuclear waste will be buried. They will have to guarantee maximum safety for the citizen. And obviously, the decisions will have to be democratized to the utmost. Reformulation of the nuclear policy will be entrusted to a committee which was recently established by the government and which will be open to the scientific community. Even the Brazil-FRG agreement, which was

signed by the Geisel administration in 1975, will be up for discussion again in this new context."

After the nuclear accident involving cesium-137 occurred in Goiania in 1988, Brazilian society was seized by the atomic "disasteritis" that had been aroused previously by the accidents at Three Mile Island in the United States and Chernobyl in the Soviet Union. Angra became the favorite target of ecologists, not only because of the human and environmental damage that would be caused by a serious accident, but also for economic reasons: the country would be unable to bear the extremely high cost of an accident of large proportions. There would be no money.

At Angra I, the nuclear waste being stored in drums in a building at the plant is a real "bomb" located between Rio de Janeiro and Sao Paulo. In order to cause injury to human life, that waste, unlike other kinds of high-risk material, does not need to explode or be detonated. All it would take is for the material not to be under a system of absolute security. In fact, the precautions taken against nuclear waste are enough to expose someone to diabolical harm.

Lacking political support, the previous administration was unable to pick a final site for Brazilian nuclear waste. There was talk of the Cachimbo Mountains in Para, where the Brazilian Air Force has a military operations and test unit. Also suggested was the possibility of using the Catarina Plain, a desert-like region in Bahia. But all the proposed sites were opposed by the states concerned. No one is willing to accept nuclear waste.

The 47 damaged tubes in the steam generator at Angra I are undoubtedly a potential threat to the entire area surrounding the plant. Jayme Lacerda, the head of the Brazilian plant, gives his personal opinion. In his view, the steam generator is exhibiting unforeseen problems with corrosion. He confirms, however, that the issue is going to be resolved not by administrative means, as Furnas claims, but in the courts and in accordance with Brazilian and U.S. law.

"We have already had several problems with original equipment that wound up being replaced with domestic equipment. The problem with the steam generator is the reason for a lawsuit brought by Furnas against the American firm in the United States. The case will be tried by the Court of Arbitration in Paris. We want compensation because just replacing the generator will cost the Brazilian Government \$100 million."

Jayme Lacerda emphasizes that the steam generator at the Ringhals plant in Sweden was recently replaced with complete success. The complicated process of replacing the generator at Angra I will require cutting through part of the plant's reactor building—first the concrete section and then the steel section—in an operation that will be extremely delicate from the radiological and environmental standpoint—and also complex in terms of engineering.

The plant has been operating at only 50 percent of its capacity, "primarily," says Lacerda, "because the energy market has not required a full load." But on the first Saturday of this month, the plant shut down again. When the doubts and suspicions concerning Angra I and the Brazilian Nuclear Program will disappear remains to be seen.

CNEN Head Santana Cites Objectives

90WP0071A Sao Paulo O ESTADO DE SAO PAULO
in Portuguese 12 Apr 90 p 11

[Article by Tania Malheiros]

[Text] Rio de Janeiro—The chairman of the National Nuclear Energy Commission (CNEN), Jose Luiz Santana, who has been in that post for two weeks, announced yesterday that he intends to "shrink" that institution and eliminate at least 30 percent of its 339 positions of trust within the next few days. According to Santana, the CNEN—which is subordinate to the Secretariat of Strategic Affairs (SAE)—will tighten its inspection of 1,800 entities and firms using nuclear energy. The commission chairman says he will assign priority to inspection so as to prevent accidents like the one involving a capsule of cesium-137 that occurred in Goiania in 1987 and killed four people.

Another objective during Santana's tenure will be to establish stricter safety rules. According to him, the previous administrations issued an average of two or three standards a year, a figure he regards as too low. "The nuclear industry is being modernized throughout the world; new techniques exist for managing it as far as safety is concerned, and they need to be implemented," he said. "If necessary, we will produce a procedural manual to guide our professionals."

In the opinion of the CNEN chairman, the organization has always been a big crazy quilt because as new responsibilities have been assigned to it, it has grown without being given the structure and tools it needs. Santana says that with 3,700 employees—many of whom are doing jobs they were not hired for—the CNEN needs a thoroughgoing administrative reform. A task force consisting of five experts has been set up to deal with that problem, and it will survey the situation in the institution within 10 days. "We have inspectors doing other jobs, and they are all going to go back to inspecting," he says. Santana predicts that without those inspectors, the CNEN will be unable to achieve another of its goals, which is to establish severe penalties for companies and institutions violating the rules.

The chairman of the CNEN promised that his administration would be one of transparency and guaranteed that the organization's participation in the activities of the Navy's Aramar Experimental Center in Ipero, Sao Paulo, would be made public. That center is part of the (military) parallel nuclear program and is not under civilian control. On Monday, according to Santana, the Secretariat of Strategic Affairs will announce the names

of those in charge of analyzing the future direction to be taken by the national nuclear program. He also says that next week, Nuclear Industries of Brazil (formerly Nuclebrás [Brazilian Nuclear Corporations, Inc.]) and Uranium of Brazil will be placed back under the supervision of the CNEN. By a decree of President Fernando Collor, the two government-owned firms have been placed under the control of the Ministry of Infrastructure. Santana also guarantees that all of the CNEN's activities will be geared strictly to the peaceful use of nuclear energy.

Future of Orbita Remains Undetermined

90WP0071B Sao Paulo FOLHA DE SAO PAULO
in Portuguese 2 Apr 90 p A4

[Article by Roberto Lopes]

[Text] Ozilio Carlos da Silva, director-superintendent of Embraer [Brazilian Aeronautics Company] (an aircraft manufacturing company connected with the Ministry of Aeronautics), does not yet know what to do with the Sao Paulo firm of Orbita, a missile and rocket manufacturing firm established in January 1987 by Embraer and Engesa [Specialized Engineers, Inc.]. Engesa is a manufacturer of armored vehicles that last week filed for a composition to avoid bankruptcy.

Ozilio has already discussed the matter with the minister of aeronautics, Brigadier General Socrates Monteiro, who asked that the decision concerning the company's future be postponed until President Fernando Collor decides how much the government is going to invest—that is, spend—in connection with missiles. The Army, Navy, and Air Force have projects in that area (see the list below). The director of the Aerospace Technology Center (CTA), Brigadier General Sergio Ferola, has already offered to help Orbita.

"He (Ferola) told me he could let Orbita take over the entire management of the Alcantara Base (the space rocket launch base located in the State of Maranhao)," said Ozilio, "or perhaps part of the engineering work for the VLS (the Satellite Launch Vehicle being built by the CTA), but it all depends on what the government is willing to spend this year, and that probably would not be much," said Embraer's superintendent in conclusion.

Orbita began life with at least three important projects: the Piranha air-to-air missile (which Embraer rechristened the MOL to please Moreira Lima, who was minister of aeronautics at the time) for the FAB (Brazilian Air Force), a surface-to-air missile for the Army (the Thunderbolt, developed in Great Britain), and an anti-tank missile, also for the Army (known as the MAF and developed in Italy). Of the three projects, only that for the antitank missile remains.

Development of the Piranha missile was interrupted by the Ministry of Aeronautics during the second half of 1988, when Engesa's financial situation became critical. At that time, by a decision of Moreira Lima, Orbita itself

underwent a "shrinkage" that drastically reduced its manpower and expenditures.

The Thunderbolt project was suspended by then Minister of Army Leonidas Pires Goncalves pending reevaluation. Orbita has completed its design of an antitank rocket—christened the ORAC-130—to be used on the battlefield by small detachments. That program would reportedly require an initial investment of about \$30 million (180 million cruzeiros on the free exchange) by the Army.

Missiles Wanted by Military

1. Army:
 - a. Antitank missile (10 units ordered from Orbita for testing).
 - b. Surface-to-air missile (for defense against low-altitude attack).
2. Navy:
 - a. Antiaircraft missile.
3. Air Force:
 - a. Surface-to-air missile for defense of air bases (the Piranha air-to-air missile is no longer a priority).

Avibras Has Biggest Project

The biggest project being carried out by Brazilian private enterprise in the field of missiles and rockets belongs not to Orbita but to Avibras [Avibras Aerospace Industry, Inc.]. Avibras (which, like Orbita, is located in Sao Jose dos Campos, Sao Paulo) has been working since the mid-1980's on its project for the SS-300, a rocket with a range of 300 kilometers. The lack of funds which forced the company to file for a composition to avoid bankruptcy on 5 January has slowed but not interrupted development of that rocket.

Ultracentrifuge Enrichment Chosen as Best Option

90WP0083A Sao Paulo O ESTADO DE SAO PAULO
in Portuguese 3 May 90 p 12

[Text] Brasilia—The task force discussing the Brazilian Nuclear Program, summoned by President Fernando Collor 18 days ago, concluded yesterday that Brazil should manufacture its nuclear fuel solely by means of uranium enrichment through ultracentrifugalization. This process was developed by the Institute for Nuclear Research (IPEN), in conjunction with the Navy, at Aramar, as part of the Autonomous Nuclear Program.

The centrifugal jet project, developed based on the Brazilian-German accord, will have to be revised owing to the unsatisfactory results attained to date; but the final decision will be incumbent on President Collor.

The third enrichment process, by laser beam, developed by the Aerospace Technology Center (CTA), will have to be maintained, but only for use in research.

The centrifugal jet process, also called jet nozzle, is used on a laboratory scale at NUCLEBRAS [Brazilian

Nuclear Corporations] Isotope Enrichment, Inc (NUCLEI), in Rio de Janeiro. Since 1982 the program has been undergoing a slowdown process, because of the high consumption of electric power used to separate the uranium isotopes: 4,000 kw/h. According to the assessment made by government technicians, the project did not represent any progress.

The investments made to date total \$276 million. To complete one of the 24 cascades of the demonstration plant (necessary for testing the process), an additional \$300 million will be required. That is the same amount spent on the autonomous program which, among other advances, enriched uranium 20 percent by ultracentrifugalization.

To suspend the research on the centrifugal jet, the Brazilian Government must still resolve two impasses. The first is political in nature, because the jet nozzle process was the only one permitted in Brazil through the accord. The second obstacle is economic, because the Germans, who are partners of NUCLEI insofar as research is concerned, do not accept the abolishment of the enterprise before 1991, when the partnership terminates.

Physicists Warn of Program's Militarization

*90WP0083B Sao Paulo FOLHA DE SAO PAULO
in Portuguese 16 Apr 90 p A6*

[Text] The Brazilian Physics Association's Nuclear Program Monitoring Commission will send to Congress a report warning of the nuclear program's militarization, and proposing the formation of a technical committee to inspect the military facilities engaged in research in that field. The document, prepared by physicist Luiz Pinguelli Rosa, the commission's reporter, claims that the government is treating the nuclear area from a strategic and military viewpoint, and not as a priority of the scientific and energy sectors.

The report suggests to the congressmen the formation of a technical committee for permanent inspection, with guaranteed access to the facilities of the Navy's Aramar Experimental Center in Ipero (Sao Paulo), which is completing the parallel nuclear program. The argument for this is that Article 21 of the Constitution (paragraph 23) stipulates that any nuclear activity on national territory will be accepted only for peaceful purposes and with approval from Congress.

Pinguelli states: "It is disturbing to learn that the civilian society has no control of any kind over the parallel nuclear program being carried out by the Armed Forces." One of his main criticisms is of the transfer of the National Commission for Nuclear Energy (CNEN) to the Secretariat of Strategic Affairs, which replaced the National Defense Advisory Secretariat (SADEN, the former National Security Council). "If nuclear energy is to be used for peaceful purposes, why not subordinate CNEN to the Ministry of Infrastructure?" he asks.

Pinguelli asserts: "It is technically clear to the Brazilian Physics Association that Aramar could produce uranium for an atomic bomb." He adds that, although sized for enriching uranium 20 percent (the rate required for the nuclear submarine), the Aramar Experimental Center has the uranium enrichment capacity for making an atomic bomb. A bomb of the Hiroshima type requires 15 kg of uranium enriched 90 percent. He declared: "The technology exists, what is lacking is money and a political decision."

The report is divided into four parts: Brazil's need to have a nuclear submarine; the technical possibility of the Navy's enriching uranium 20 percent; the viability of Brazil's building the atomic bomb; and the need for Congress to control the nuclear program.

In the first part, the document, based on the Navy's report, questions the need for the country to develop a nuclear submarine. "It is a technological challenge, but not a strategic necessity, since Brazilian policy has been to emphasize defense, and for that a traditional submarine would suffice," claimed Pinguelli. He added that the nuclear submarine is intended for long distances.

The report states that Brazil has the technical potential to enrich uranium over 20 percent (the rate specified in the program for the nuclear submarine) in the Aramar facilities, and it defends inspections of the Navy's facilities by civilian technicians.

In the third part, based on documents from U.S. physicists, it maintains that Brazil could make the bomb. In its final part, the commission cites its intention to request that Congress assume responsibility for inspecting all areas of the Brazilian nuclear program. The report proposes to Congress the formation of a technical advisory committee to guarantee the peaceful use of nuclear energy.

Carnegie Charges of Smuggling Sourced to Press

Sources Identified

*90WP0077A Sao Paulo O ESTADO DE SAO PAULO
in Portuguese 18 Apr 90 p 9*

[Article by Paulo Sotero: "Press Supplied Material for Study"]

[Text] Washington—The inclusion of Brazil on the list of five countries accused by the Carnegie Foundation for International Peace yesterday of secretly purchasing components to expand nuclear programs which are not covered by international safeguards was based on reports published in the Brazilian and American press, as well as the results of an investigation into exports of nuclear equipment carried out by the parliament of the FRG.

Prof. Jose Goldemberg, the secretary for science and technology, who is in Washington to participate in an international meeting on climate changes, told O ESTADO that he was familiar with the general outline of

the study which led to the accusation. And he criticized its author, Leonard S. Spector, director of the Carnegie Nuclear Nonproliferation Project, which is a study center and lobby for liberal causes. "Spector's work extrapolates and arrives at exaggerated conclusions," Goldemberg said. The secretary stated that work has not yet begun on the organization of the interministerial commission which President Fernando Collor de Mello promised prior to his inauguration to appoint to reexamine the current position of the country as a nonadherent to the Treaty on the Nonproliferation of Nuclear Weapons.

Spector devotes three of the 38 pages of his study to Brazil's "parallel nuclear program." The work is based on "intelligence service reports" from Germany quoted in the issue of the periodical NUCLEONICS WEEK published in July of last year. It states that the Navy's pilot plant for uranium enrichment in Ipero has the capacity to produce material enriched to the 70-percent level, practically that required for the production of a bomb, rather than 20 percent, as was previously believed.

Spector goes on to refer to a statement which Adm. Othon Luis Pinheiro da Silva, coordinator of the Navy's special projects, made to JORNAL DO BRASIL in June of 1988. In that statement the officer said that he "had personally obtained from West Germany, on false pretexts, a special lathe for the fashioning of cylinders for the Ipero centrifuges." The study further quotes an interview which Rex Nazareth, who was at that time president of the National Commission for Nuclear Energy, gave to the newspaper O GLOBO in April of last year, in which he admitted "that his country had illicitly obtained essential (nuclear) material abroad," and that this "was probably known to the United States." Spector quoted a statement attributed to Nazareth. "The thing is that they (the United States) have no way of proving it. I would not say a word about it, even under torture. Perhaps some day, when I write my memoirs, I will recount how it was done."

The Carnegie study also charges that Brazil transferred equipment and personnel from its civilian program, which has operated under international safeguards in accordance with the 1975 Brazilian-German agreement, to the "parallel nuclear program" being pursued by the Armed Forces. This charge is based on a German Ministry of Foreign Affairs report quoted in NUCLEONIC WEEKS in July of last year.

The Brazilian Government recently decided to hire the services of the French state firm Arianespace to put two new telecommunications satellites into orbit. Brazil will buy the satellites from the Hughes Aircraft Corporation, a subsidiary of General Motors, and the decision to orbit them is likely to renew American interest in the Brazilian nuclear program in the coming years. One of the key elements in the contract with Arianespace is the transfer to Brazil of the liquid rocket fuel technology. Brazil claims it needs this technology to make the production of

a satellite-launching vehicle feasible, and in order to break into a potentially profitable market in the future. The United States, which is losing ground in that market, does not accept this explanation, and suspects possible links between the parallel nuclear program and the order placed with Arianespace. As a result, it is putting pressure on the French.

Criticisms Scored as Hypocritical

90WP0077B Sao Paulo O ESTADO DE SAO PAULO
in Portuguese 18 Apr 90 p 9

[Article by William Waack]

[Text] Great hypocrisy prevails when the efforts of countries like Brazil, Argentina, and Pakistan to achieve mastery of the complete nuclear fuel cycle are criticized (regardless of the goals). Such mastery means possession of the technologies which serve equally to produce reactor fuels (and to process their waste) and to produce the material for nuclear bombs.

Strictly speaking, the leading industrialized countries, particularly Germany, France, and England, in addition to the United States, knew that their fierce competition on the world nuclear market in the decade of the 70s would have consequences like this. The nuclear agreement between Brazil and Germany was perhaps the best example of how a less-developed country (Brazil) could take advantage of the stubborn competition between the great nations (Germany and the United States, in this instance) to obtain strictly controlled technological assets.

It is not a question of looking for the "guilty parties." For at least 15 years, a number of voices have been raised within the U.S. administration itself to say that it is better to establish a reliable political cooperation and integration system than a whole range of restrictions, controls, and hindrances which, as can be seen, prove to be useless.

Behind the impulse which leads countries like Brazil or Argentina to pursue this sensitive technology, there is more than just military factors or a false perception of security. There is the belief—and not without a good portion of real foundation, moreover—that the more-developed countries are denying the less-developed countries access to state-of-the-art technological goods.

And they are doing so not only in an attempt to retain their influence (for which read power) on the international level, but mainly due to purely commercial considerations. At least the Brazilians know what prohibitions the appetite for profit and orders helped to break down when they signed their nuclear agreement with the Germans. And there is no indication that this has changed.

International Inspection Rejected

90WP0077C Sao Paulo O ESTADO DE SAO PAULO
in Portuguese 18 Apr 90 p 9

[Text] Brazil has mastered the technology for enriching uranium, but the authorities in the nuclear sector refuse to say officially if the country is or is not in a position to produce its atomic bomb. The new president of the National Commission for Nuclear Energy, Jose Luiz de Carvalho Santana, merely notes that the Constitution prohibits nuclear activities for nonpeaceful purposes, and that for this reason, the country will not produce the bomb.

Santana, who has occupied his post for less than a month, says that the entire nuclear program will be reviewed, and he advocates congressional screening of all of the nuclear activities of the country, including the parallel nuclear program being developed by the military. He also says he favors technical inspections by civilians at all of the nuclear installations in Brazil, including the Navy's Aramar Experimental Center in Ipero, Sao Paulo. However, he is unwilling to agree to international inspection, because he believes that "very strong international economic pressure is being exerted to block our technological development."

The Commission To Follow the Nuclear Program, appointed by the Brazilian Physics Society, says that Brazil is in a technological position to build the atomic bomb. "What is lacking is the money and the political determination," Luiz Pinguelli Rosa, the reporter of a commissioned document which is to be sent to the Congress, asserts.

The document warns against the militarization of the nuclear program, stating that the Brazilian government is taking a strategic point of view toward this sector, rather than a scientific or energy approach. And the Congress is asked to appoint a technical commission to supervise the entire nuclear program, particularly the parallel activities being pursued by the Armed Forces. Luiz Pinguelli criticizes the fact that the National Commission for Nuclear Energy has been subordinate to the Secretariat for Strategic Affairs.

Budget Cuts Said To Thwart Aramar Progress

90WP0076B Sao Paulo FOLHA DE SAO PAULO
in Portuguese 10 Apr 90 p A4

[Text] Brasilia—Adm. Mario Cesar Flores, the naval minister, said yesterday that the Navy is prepared to accept the revision of the Brazilian nuclear program. According to the minister, the Navy budget for this year will not permit advances in the technological development of the Aramar Center in Ipero, Sao Paulo. "The resources available are only 50 percent of what would be needed to maintain the rate of progress in the research," he said.

Flores stated that at the current stage in the studies at the Ipero Center, the process for enriching uranium "has

now been mastered." The next step, the minister said, is to "convert the technical process into industrial production."

He said that there is no concern in the military sector about a possible recession caused by the economic adjustment measures included in the Collor Plan. "There is no concern about a sensitive situation on the national security level," the minister asserted. "If the plan leads to some recessive process, it will be kept under constant control," he added.

According to its head, the Ministry of Navy, "with a rather reduced budget," was not affected by the measures included in the plan to reduce expenditures. "We did not have to submit to cuts because we never had any fat to be trimmed," he said. There are 73,000 persons in naval service, of whom 16,325 are civilians. "The greater part of the civilian personnel is made up of expert technicians, and it is hard to do without them."

The principal programs of the Navy, according to Cesar Flores, involve submarines and corvettes. On the basis of an agreement with Germany, Brazil is building three conventional submarines and four frigates. The construction schedule for the submarines calls for the delivery of one every year beginning in 1991. The frigates are to be delivered over a period of five years.

Cesar Flores said that the program for Antarctic exploration will be maintained, and the annual expedition made for study purposes will also take place this year. However, studies will be limited to the continental shelf.

IBAMA, CNEN To Monitor Activity

90WP0076A Sao Paulo O ESTADO DE SAO PAULO
in Portuguese 19 Apr 90 p 12

[Interview with Jose Luiz Santana Carvalho, president of the CNEN, by Rubens Santos in Brasilia; date not given]

[Text] Brasilia—At two meetings held in the Planalto Palace this week, significant changes in the policy Brazil will adopt for the nuclear sector were defined. Some enterprises affiliated with the National Commission for Nuclear Energy (CNEN) may be transferred to the private sector. They include, for example, the NUCLEMON [NUCLEBRAS Monazite and Associated Elements, Ltd] and Nuclear Industries of Brazil (INB S/A). The new government will not sign the Treaty on the Nonproliferation of Nuclear Weapons (TNP), and the CNEN will work with the Brazilian Environmental and Renewable Natural Resources Institute (IBAMA) to supervise the nuclear installations. The president of the CNEN, chemist Jose Luiz Santana Carvalho, told reporter Rubens Santos about the details of the new Brazilian nuclear policy.

[Santos] President Fernando Collor has indicated great concern about the environmental issue. How do you plan to reconcile this plan with the development of nuclear energy?

[Santana] My concern about the environment is also very great. For this reason, we are going to intensify supervision of the nuclear sector, drafting norms and coordinating our efforts continuously with the Secretariat of Environment. Within a few days, the CNEN is to sign a cooperation agreement with the IBAMA on active supervision of the sector. The CNEN will supply technicians, equipment, and facilities to ensure that the activities of the autonomous program do not harm the environment. We will maintain strict supervision of the hospitals, clinics, university laboratories, industries, factories, and other nuclear facilities.

[Santos] Would this not be merely an effort to modify the opposition of the Greens, who oppose the nuclear sector?

[Santana] It is interesting to note here the example set by a Scandinavian country, one of the pioneers in the battle to preserve the environment. That country suspended its nuclear program, bought energy from other countries, and now finds itself faced with a contradiction. The demand for energy is increasing, the supply of electrical energy remains stable, and this means a decline in the capacity of the products to compete, an increase in the level of unemployment, and an increase in environmental pollution.

[Santos] Would this country be Sweden?

[Santana] It would be unseemly to mention the country by name. But there is even talk there of reviving nuclear projects.

[Santos] You have emphasized the benefits of nuclear energy, but you have made no mention of its unpleasant consequences, such as atomic waste and accidents.

[Santana] It is obvious that we have problems, such as the refuse. And it is also clear that some accidents have had profound consequences. But the technology involved in nuclear safety nowadays has reached a very high level, and this is the result of pressure from the environmentalists. It has now been demonstrated that nuclear energy is clean in environmental terms.

[Santos] If it is so clean, what is the reason for so much secrecy?

[Santana] Any industry in a strategic sector must be secret. There is nothing surprising about this. Even the American universities, in a highly democratic society, keep the technologies they develop secret.

[Santos] Does this mean that Brazil will manufacture its atomic bomb in absolute industrial secrecy?

[Santana] We are not going to build an atomic bomb of any sort. There are no plans for bombs on the researchers' drawing boards, but there is a copy of the Constitution.

[Santos] It is said that you undertook an exhaustive investigation within the CNEN, with a view to eliminating everything reminiscent of former president Rex Nazare.

[Santana] That is not true. This disagreement they talk about is foolish. The actions of Dr. Rex Nazare at the head of the autonomous program in the CNEN were praiseworthy.

[Santos] Do you now have a solution to the problem of final disposal of the radioactive waste which was produced by the accident involving the cesium 137 in Goiania?

[Santana] The development of a final disposal site still depends on a number of technical, scientific, and political factors. What exists now, therefore, is merely speculation. A draft law on this matter is in the hands of the National Congress.

CNEN Seeks New Radioactive Waste Sites

90WP0086A Sao Paulo O ESTADO DE SAO PAULO
in Portuguese 11 May 90 p 10

[Article by Laurence Neves]

[Text] Goiania—Jose Luis Santana, the new president of the National Commission for Nuclear Energy (CNEN) announced to the Goias Legislative Assembly yesterday the three localities selected on a technical basis for the final storage of the city's radioactive waste. The probable locations are Abadia de Goias (20 km from Goiania), where the waste has been for almost three years; an area between Guapo (40 km from Goiania) and Jandaia (120 km from Goiania); or, an area between Jandaia and Indiará (100 km from the capital city). All of these areas lie beside Highway GO-060 in the southwestern part of the state.

The president of the CNEN also announced that the federal government will resume talks with the Italian Casagrande group, which had offered to provide the technology and financing for the construction of a storage facility for cesium-137. The talks were first initiated by Governor Henrique Santillo, but were interrupted by former president Jose Sarney, who preferred to use domestic resources and technology exclusively. Although he stated that the CNEN as well is concerned about the durability of the drums at the Abadia site, which have already been in use for the maximal safety period (three years) indicated for that type of waste in the open air, Santana did not make any promises to the representatives of the community of Goiania. He noted that the legislation on these matters is confusing, and he stated that he had come to Goiania "in search of assistance in finding a joint solution."

At the beginning of the afternoon, immediately after his arrival in Goiania, Santana visited the Abadia site in Goias. He said that he was accompanied by two of his "strictest supervisors"—the director of the Nuclear

Safety Division, Anselmo Paschoa, and the manager of the CNEN Health Program, Luiz Hiroshi Sakamoto.

"The situation is not worrisome. Only a few drums had begun to show rust, and they have been replaced, which is absolutely normal," he said. He stated that he is satisfied with the environmental supervision work being done in Abadia.

Wearing disposable plastic boots and using cane-like devices to measure the levels of radiation received, they stayed at the waste site about half an hour, but they did not come too close to the location of the frame containing the cesium bomb and the cover intended to serve as a jacket should the capsule break.

Construction of SNAC-1 Submarine Discussed

90WP0086B Sao Paulo FOLHA DE SAO PAULO
in Portuguese [Science Section] 4 May 90 G1

[Article by Ricardo Bonalume Neto]

[Text] President Fernando Collor is scheduled to make a run day after tomorrow on the Tupy, a submarine built in West Germany. Thanks to the flexible technological policy adopted by the Navy, his successor may be able to make the same trip on a submarine designed and built in the country—the National Submarine 1 (SNAC-1).

"The Navy is doing a very intelligent thing," researcher Miguel Angel Buelta Martinez, 39, of the Naval Engineering Department at the USP [Sao Paulo University] Polytechnical School, says. Instead of a transfer of technology, to use an expression which is very much in fashion, the Brazilians have chosen the transfer of know-how.

"People forget that before the construction stage, there must be a design stage, which is more brain-intensive. Seventy percent of the know-how goes into the planning," the "father" of the SNAC-1, Vice Adm. Elcio de Sa Freitas, 54, who heads the Naval Engineering Directorate of the Navy, says.

At first glance, the admiral's rhetoric seems nationalistic. He says that the "peripheral" countries can manufacture things, but that designing is still done in the "central" countries, which formerly dominated "physically," but do so today through know-how. The flexibility of the policy adopted by the Navy is revealed in the way the planning stage is being nationalized, involving the crucial participation of Sao Paulo University.

"We are entrusting the most prestigious parts of the project to the USP," Admiral Elcio says. The entire hull design was drafted by the Naval and Oceanic Structures Center (CENO) at the USP Polytechnical School. The hull of the submarine is its most delicate part, because it is subjected to high levels of pressure at depths of tens and sometimes hundreds of meters below the surface of the water. The hull structure, in the final analysis, carries the "responsibility for 100 percent of the submarine,"

according to Buelta Martinez, the technical coordinator of the project at the USP. Or, as Admiral Elcio put it, "A defect in the hull can kill everyone."

The liaison with the university is one of the key aspects of the Navy's policy, because it makes the ongoing training of expert human resources possible. "The USP is making a contribution to the Navy, and it is gaining greatly thereby," Martinez says. The researchers are paid for their assistance, and the project leads to theses for master's degrees and doctorates.

Part of the difficulty in designing a submarine derives from its military, and therefore secret, nature. To succeed in gathering the data is in itself an achievement. The Brazilian planners are even appealing to the vanity of their foreign colleagues in order to obtain important information. "There is no researcher who will not talk when he is challenged," the USP professor says. It suffices to know what to ask, but not everyone knows how to ask. "We have even had to search for the questions," Admiral Elcio says.

Innovations Involved

The design of the SNAC-1 should be ready by the middle of 1991, and if the resources are available, the construction should be finished in 1997, according to Capt. Jorge Tratch Junior, 43, who heads the Technical Department of the Naval Engineering Directorate. Of the approximately 6,000 technical documents required, some 1,700 are ready. The USP already has 90 percent of the structural portion designed, according to Professor Buelta Martinez.

The planners are creating a model on a scale of 1:5 (only one-fifth the size of the actual vessel, i.e., 12 meters in length) in order to see if there is room for all of the pipes, wires, and tubes. The SNAC-1 is constantly being redesigned in order to incorporate technological innovations. By the time it is ready, the submarine will face more sophisticated enemies than those which exist today. "The submarine must be a weapon, and not a target," says the project manager, Commander Rogerio Augusto Calixto, 41.

Achieving the Impossible

In drafting the design for the SNAC-1, the Tupy, the submarine Collor will inspect, played an important role. It was built in Germany, and three others like it are to be built for the Naval Shipyard in Rio. But it is not simply a question of assembling the three in the country. The Brazilians were probably the most difficult customers for the German submarines of the 209 type, designed by Ingenieurkontor Luebeck (IKL) and built by Howaldtswerke (HDW). "We demanded the impossible," in other words a breakdown of the design and construction, Vice Admiral Elcio de Sa Freitas says.

During a visit paid by Vice Admiral Elcio to the HDW installations in Kiel (in the northern part of Germany), the personnel at the shipyard proudly showed him a

209-type submarine belonging to another country which had been returned for a complete overhaul after five years of service. "That is precisely what we do not want," the admiral says. One of the goals of the Navy is to nationalize the maintenance of its equipment. Other countries which have submarines of the 209 type have made different choices. "Argentina and Peru bought black boxes," Miguel Angel Buelta Martinez, of the USP Polytechnical School, says.

Another important step in the development of the Navy's capacity to design modern vessels involved the corvettes of the Inhauma class. The index of domestic production of the equipment for these vessels (with the exception of the weapons systems) was about 80 percent, calculated in terms of cost. Vice Admiral Elcio does not like that criterion, because the mere fact that something was produced in the country does not mean that the know-how was available. As he says, "It is only the knowledge which enables you to nationalize effectively." Instead of manufacturing everything, the Navy prefers a more flexible policy. The priority for nationalizing is assigned to the mastery of the design engineering, the manufacture of frequently needed replacement parts, and the mastery of maintenance engineering, as well as training courses in technologies which may have other applications in domestic enterprises. For example, nationalizing electronic equipment is more important

than producing the electronic consoles here. The know-how for producing deep-water oil platforms is a byproduct of the technological mastery of the materials and computations involved in submarine structures.

The hulls of the submarines of the Tupy class are being manufactured in Rio by NUCLEP [NUCLEBRAS [Brazilian Nuclear Corporations, Inc.] Heavy Equipment, Inc.]. Two USP engineers are supervising the construction work. The structure of a submarine requires working with much greater precision than when building a surface vessel. The hull must be strictly circular, with a margin of error of six to eight millimeters in a diameter of 7.8 meters, Vice Admiral Elcio says. "It is good to have no defects in a corvette, while in a submarine there simply cannot be any," Buelta Martinez says.

Principal Characteristics

In approximate values, the new submarine will have a total length of 67 meters and will displace 2,600 tons when submerged. The diameter of the resistant hull will be eight meters. The submarine will operate at a maximum speed of 20 knots (37 km per hour) and at a maximum depth of 250 meters. It will carry a crew of 42 men and will have a radius of action of 11,000 nautical miles (20,300 km).

EGYPT

Nuclear Power Viewed 'Only Choice' of Sufficient Energy

90WP0078A Cairo AL-MUSAWWAR in Arabic
13 Apr 90 pp 28-31, 64

[Interview with Dr. 'Ali al-Sa'idi by Sulayman 'Abd-al-'Azim; place and date not given: "Why It Is Necessary for Egypt To Rethink Its Position on Nuclear Energy"—first nine paragraphs are AL-MUSAWWAR introduction]

[Excerpts] To be sure, the explosions at the American Three Mile Island [TMI] reactor and the Soviet Chernobyl reactor have compelled a large number of world countries to vehemently abandon plans to build nuclear reactors on their territory to meet their energy needs.

And Egypt is one of those countries.

The construction of the al-Dab'ah reactors has been halted at a time when Ministry of Electricity official reports confirm that we will be in urgent need of 1,000 megawatts of electric power per year for the next 12 years.

The curious thing is that up until now no one exactly knows from where or how to meet this need.

Some nuclear energy opponents may say from oil and natural gas, but how can we rely on these two sources which, as local and international official reports confirm, will be depleted in the nineties?

Those "enlisted" to use coal to generate electric power may say: Here is the coal! And we on our part say: How can we depend on coal which we import and which pollutes the environment? Moreover, the cost of coal-generated electric power is almost the same as power generated by a nuclear reactor.

Some nuclear energy opponents may demand the use of water sources, but experts and scientists emphasize that these sources were used up when we built the Aswan reservoir and the High Dam.

Some of them may advocate the use of new and renewable energy such as the sun and the wind. But can we rely on unstable costly sources—on which no developing country can rely since in the majority of cases they will provide no more than five percent of the total electric power consumption in Egypt?

In this interview, Dr. 'Ali al-Sa'idi, head of the Nuclear Electric Power Plants Authority, answered all these questions aimed at arriving at a specific answer to whether the construction of the Dab'ah reactors is a necessity or a luxury for Egypt.

['Abd-al-'Azim] What are Egypt's needs for electric power in the coming years? How can they easily be met without hazards? Why the current focus on Egypt's need to join the nuclear fold?

[Al-Sa'idi] We have to look at the energy issue from a universal point of view because it is the mainstay of development. We cannot at all say that we can achieve development without the various kinds of energy sources.

In order to provide energy, we ought to determine what the long-term requirements are and why this is so. Energy-generation plants take a long time to establish, hence the need for thoughtful and realistic projections. A look at our Egyptian reality shows that our development has been recently proceeding at a rate of about 6 percent while electric power consumption has been proceeding at a higher rate because social development in our country hungers and thirsts for prosperity and urbanization so much that it compels us to adopt much higher energy consumption patterns than that of European countries, perhaps twice the energy consumption of Europe!

It has been projected that, by the year 2002, we will need 22,000 megawatts of capacity compared to the 10,000 megawatts we now have. Therefore, from now up to the year 2002, or in the next 12 years, we will need close to 12,000 megawatts. Naturally, this estimate may be lower or higher, depending on growth and development, but the problem is that we cannot wait for electric power energy to happen. That is why it is better to have a higher rather than a lower reserve. It is an internationally acknowledged fact that the available reserve ought to be 120 percent higher than the actual need.

['Abd-al-'Azim] how can this electric energy be provided or acquired?

[Al-Sa'idi] If we look at the sources and resources available to us, we find that we used up our water energy when we built the High Dam and the Aswan reservoir. If we look at oil and natural gas, we find that 75 percent of the electric power in Egypt is generated by oil and natural gas. This is a waste of our resources, which can be used more economically than burning them just to generate electricity. You may ask me why. My answer is that two-thirds of the oil and natural gas are lost in the air, whereas these sources can be used in petrochemical and processing industries for fertilizers. It is an internationally acknowledged fact that oil and gas supplies will run out. It is always said that most of our proven reserves will run out in the nineties. New wells and new fields may be discovered, but we cannot devise future plans based on unproved reserves.

['Abd-al-'Azim] If oil and natural gas will be depleted in this decade, perhaps coal can be used as an energy source?

[Al-Sa'idi] Our coal capabilities as a source of electric power generation are nonexistent because the coal found in Sinai is not enough to operate one electric power plant for its lifetime. Furthermore, it is more fit for the manufacture of coke than for electric power production. Therefore, if we are to rely on coal, we have to obtain it from foreign sources which are all far away: Australia,

China, Canada, northern Europe and Colombia. Moreover, these sources pose some strategic perils because, in order for them to get to Egypt, they would have to pass through known "bottlenecks" which could damage them. Furthermore, we cannot strategically store more than a three to four month supply. Therefore, relying on a foreign source in the absence of a reserve large enough to last for a long time is a very serious matter.

[Abd-al-'Azim] All international specialized conferences, the latest of which was the World Energy Conference held last September, have been very outspoken about the fact that new and renewable energy cannot be relied upon to meet major electric power needs and may only help with two to three percent. There is little hope of it contributing more than that. So what is the best option for Egypt?

[Al-Sa'idi] The only choice we have is the nuclear option. This option is not a novelty, for many countries have turned to it and are going full speed with it. In recent years, before the Chernobyl disaster, the unmistakable general feeling used to be that excessive coal and oil use for power generation would cause an environmental disaster in the world and that the use of nuclear energy for power generation will at least soften such a disaster.

The second thing is that nuclear energy has undoubtedly and uncontestedly been proven to be the most economical. This is the reason why some developing countries that have embarked on major development programs, such as India, South Korea, Taiwan, China and, later, Indonesia, are turning to nuclear energy in a big way even though they have other sources of energy. Had these countries found sources other than nuclear energy, they would have used them. For countries like China, the Soviet Union and India have the largest stock of coal in the world and yet they have each embarked upon a massive nuclear program.

[Abd-al-'Azim] In the wake of the TMI incident in Pennsylvania and the Chernobyl incident in the Soviet Union, however, fears about turning to the nuclear option have been heightened.

[Al-Sa'idi] There are basic fears about Egypt embarking on a nuclear program and a large number of Egyptian scientists may be apprehensive about nuclear technology. Some politicians and sociologists have many apprehensions about the nuclear option. The general view of the Egyptian scientific scene says that there is much prejudice and that our scientific education has not yet joined the nuclear age.

In Egypt, the Chernobyl accident scared an Egyptian public which had not been prepared to accept the nuclear option concept.

[Abd-al-'Azim] How can these fears be precisely identified?

[Al-Sa'idi] There are "technical" fears that nuclear technology is incompatible with society. There are "economic" fears based on the notion that we are unable to finance a nuclear project and there are fears stemming from world incidents.

If we were to discuss these Egyptian fears, we would say the following:

First, nuclear energy is different from all other technologies. It is not closed to anyone. Rather, it is governed by the international technical-scientific community. For example, because of the TMI and Chernobyl accidents—the difference between them notwithstanding—we cannot design and build a nuclear plant unless the international nuclear community ascertains that what we are doing does not pose any danger whatsoever.

[Abd-al-'Azim] How is that?

[Al-Sa'idi] The TMI reactor had a fire inside it and it had been designed in such a way as not to emit radioactive material in case of a mistake inside the reactor. And since such accidents have been anticipated by the scientists, it cannot be said that the reactor was badly designed or flawed. Rather, it is viewed as an economic loss for the United States. They have benefited from it by making sure it is not repeated in the other six reactors of this type out of 430 nuclear reactors in operation worldwide.

With regard to the Chernobyl accident, East Europe and the Soviet Union had a closed nuclear technology at the time it happened and were not open to the Western philosophy of maintaining the highest standards of nuclear safety. They depended more on individuals than on the machine itself for safety, claiming that they wanted to save safety costs. Add to that the fact that the Chernobyl design itself, which is different even from other reactors manufactured in the Soviet Union, like the one India bought, has not been exported to any other country, including within the Eastern bloc. Owing to their hazards, the entire nuclear community has consistently refused to use these particular designs whereas Soviet scientists have insisted that design problems could be averted through "human control." As a result, the reactor's operators are the ones who caused the accident.

[Abd-al-'Azim] Some may believe that the Pennsylvania and Chernobyl accidents are enough reason for us not to think about joining the world of nuclear reactors.

[Al-Sa'idi] Nuclear technology cannot be judged by these two accidents alone. For with the exception of Chernobyl and TMI, no person has been hurt by radiation or death. Even Chernobyl, which is hazardous all around, did not cause more than 30 deaths and 200 cases of exposure to radiation. True, the Soviet authorities evacuated thousands of people, but this was a precautionary measure taken even when building a water dam along any river. Naturally, this is not to say that we sanction the incidents

at Chernobyl and TMI. What we are saying is that these kinds of accidents can be handled.

[Abd-al-'Azim] Some people from outside the nuclear fields have expressed certain reservations about the qualifications of Egyptians handling the nuclear reactor. What do you say to that?

[Al-Sa'idi] From a technical point of view, we cannot say that Indian technicians, Brazilian technicians, Mexican technicians or Argentinian technicians are better than Egyptian technicians. The Egyptian man who operated the Suez Canal, in spite of the entire Western world's plot to foil it, is not an average but rather an experienced human being. The same thing goes for operating a nuclear plant. Given the fact that nuclear plants are complete technical-scientific communities that require a particular type of person, we will bring in experienced specialists.

From an economic point of view, some people may wonder where the money will come from. The real question is where the money for a coal-operated electric power plant will come from, particularly since such a plant with environmental safeguards costs almost the same as a nuclear plant, and without these safeguards used to cost almost 65 percent of this amount. The cost now has gone up by 30 to 40 percent. Speaking in millions of pounds, a 600-megawatt nuclear-fueled plant costs 1.2 billion pounds and the same coal-fueled plant costs from 1 billion to 1.1 billion pounds—1.2 billion pounds in Western countries where the environment is more of an issue. Cost is not that important; the operating expense is more important. Running a nuclear-fueled plant requires one-third the cost of a coal-fueled one, hence using nuclear fuel to generate power is more advantageous to the balance of payments than using coal. If nuclear plants were more costly or hazardous, countries like India, South Korea and China would not have entered the nuclear field.

[Abd-al-'Azim] But where will Egypt get the money to build nuclear plants, especially since, as everyone knows, it is going through some trying economic times?

[Al-Sa'idi] So long as we are in need of electric power, I will get it either by using coal or through nuclear plants and, in either case, I will find the money. We should be asking whether it is better to finance a project that produces cheaper kilowatt-hours at lower costs or to finance a more expensive project that runs a higher fuel bill and does not have environmental safeguards. Moreover, financing is easy. Why? Because we sell the power we produce and, therefore, electric power projects pay for themselves. Nowadays, power is a commodity rather than a non-income-generating service like sewage or roads, especially since the price of a kilowatt-hour is now going up to an economic level that would certainly take care of the money problem. Moreover, part of the oil revenue is put aside for the alternate energy fund which is used to finance nuclear plants. This is demonstrated by the fact that when we offered an international bid to

build the Dab'ah plant in 1983, we received money from all the countries that took part in the project, underscoring the fact that a nuclear plant can repay loans. You should know that the price of a kilowatt-hour of electricity produced by nuclear fuel is 0.8 percent less than that produced by coal.

[Abd-al-'Azim] About choosing the city of al-Dab'ah as the nuclear plant site, let me ask you: What kind of dangers would the al-Dab'ah reactor, should it be built, pose to the Delta and Cairo, especially since scientists emphasize that an accident at the Israeli Dimona reactor would have a greater impact on the Delta and Cairo than one at the Egyptian al-Dab'ah reactor?

[Al-Sa'idi] First of all, in the event of an accident, any nuclear reactor, large or small, can be dangerous. The primary objective, when building a nuclear reactor, is to avert accidents or prevent radioactive emissions from the reactor that affect human beings. In choosing a site, all possibilities and situations, including accidents, are taken into account, in that a safety belt containing a limited population is installed around a reactor site. This belt differs from one country to the next. Some countries set the nearest residential area at 600 meters away from the reactor, others at 1,000 meters and some at five kilometers, and so on.

When we picked al-Dab'ah as a site for the nuclear plant, we studied wind direction, stream beds and the groundwater found at the site so that, in case of an accident at the reactor, nearby residential centers would not be affected. You know that the first site was Sidi Krir, but in the wake of world scientific studies and in view of its proximity to Alexandria's industrial expansion, we preferred to look for another site, which was al-Dab'ah. This is an outstanding site because, even in the event of an accident, radioactive material would not under any circumstances get to the residential centers located around al-Dab'ah. As I always say, reactor designers and operators cannot be thinking about accidents, because otherwise nuclear reactors would not have seen the light of day in the first place.

Finally, I say that the al-Dab'ah site satisfied all international nuclear safety standards and elements and, based on these standards, I regard this site as the best location for building nuclear plants. Four nuclear plants were supposed to be built on this site.

As for the second part of your question, if we look at the wind directions, we find that an accident at the Israeli Dimona reactor would have a greater impact on the Delta than one at the Egyptian al-Dab'ah reactor.

[Abd-al-'Azim] Besides its strategic and safety hazards to Egypt and the region, the Israeli nuclear project poses great environmental hazards to the region. My question is: Do you hold Israel responsible for the decline of the environmental system in the region?

[Al-Sa'idi] The purpose of building any technological project is to put the technology to the best use in the

sense of using the technology while ensuring that it does not affect the environment. The site selection process is governed by technical and scientific factors, including environmental considerations. There is no intentional environmental pollution. I do not want to judge that the Dimona reactor has an impact or anything like that in the absence of accidents. We are saying that, if we are afraid of nuclear reactor accidents, we have a greater reason to be more afraid of the Dimona reactor than the al-Dab'ah reactor.

[Abd-al-'Azim] Why?

[Al-Sa'idi] The Israeli Dimona reactor is located 25 kilometers away from our eastern borders, in Shivta, which is east or northeast of al-'Awjah [called Nizzana in Hebrew].

[Abd-al-'Azim] What are the prospects for Arab technological cooperation in the peaceful use of nuclear energy, especially in view of contentions that our Arab scientific capabilities are still not up to par?

[Al-Sa'idi] Most of the technological activities in the Arab countries, including nuclear energy, have been shouldered by Egyptians. We all remember the late Dr. Yahya al-Mushud who participated in the Iraqi nuclear program and was assassinated for that reason. If we look at the other Arab countries, be it Libya or others, we find that Egyptian scientists have contributed to the development of their nuclear scientific programs or technology. [passage omitted]

[Abd-al-'Azim] Given the widely-publicized opposition to Egypt joining the nuclear program under the pretext that there is no dividing line between peaceful and military use, tell me specifically what major obstacles is the Egyptian nuclear program facing?

[Al-Sa'idi] We may be wrong in assuming that the world does not support Egypt's entry into the nuclear field. The real issue is how the advanced world views developing countries in general. The important question is: Would the industrial countries approve or encourage the developing countries' entry into an energy source that they control? The answer is in the negative. We know that developing countries have oil and gas energy sources. If these sources dry up, the industrialized countries have nuclear energy in its present form and will have it in its more advanced future forms, such as quick reactors and nuclear fusion. On their part, the industrial countries believe that in this way they can control the developing countries and therefore have no interest in encouraging developing countries or in giving them advanced nuclear technology.

Generally speaking, as Egypt is one of the leading countries in the Arab region and the African region, the advanced countries do not encourage its entry into the nuclear field. Add to that a host of other factors, such as economic and regional relations. All these elements figure in the decision to transfer certain technologies to

certain countries, including Egypt, given its highly sensitive position that could have an impact on the decision itself.

However, I would like to assure those who are uneasy about this issue that it was Egypt's entry into the nuclear field that prompted it to sign a number of international agreements with a multitude of sources that can supply it with the kind of nuclear technology that we need wherever we need it. Therefore, I believe that, should we decide to enter the nuclear field, the doors will not be closed in Egypt's face.

Alleged Conspiracy Behind Deaths of Arab Scientists Discussed

90AE0036A London AL-MAJALLAH in Arabic
16-22 Aug 90 pp 12-14

[Article by Ayman al-Sayyad: "After Subjecting Them to Psychological Threats and Pressures, Who Is Assassinating Arab Nuclear Scientists; Budayr's Wife to AL-MAJALLAH: We Were Subjected to Severe Psychological Pressures in Germany; What Is Austrian Secretary's Relationship With Endeavor To Prevent Budayr From Leaving Germany"]

[Text] Cairo—Samirah Musa, Yahya al-Mishadd, Sa'id Sayyid Budayr and others share a common characteristic: They are Arab nuclear scientists who have been assassinated under mysterious circumstances and at various times. The latest was Budayr who is alleged to have committed suicide a few weeks ago, whereas his wife asserts that he was killed and that he had been subjected to psychological threats and pressures by unidentified circles.

Who is killing the Arab nuclear scientists and what is the role of the Mosad (Israeli intelligence) in this regard? What is the position of the Arab organizations specialized in atomic energy?

AL-MAJALLAH will try to answer these questions through the following report.

When Yahya al-Mishadd, an Egyptian nuclear scientist, was killed in the summer of 1980, Israel's radio said: "Al-Mishadd had expertise in atomic energy and his death will delay the Iraqi nuclear armament process which was likely to put Israel in an extremely difficult position." The comment of Israel's radio reflects why the Arabs have been losing their scientists to murder one after the other. The mysterious circumstances under which Dr. Engineer Sa'id Budayr, a young Egyptian scientist, was killed in Alexandria a few weeks ago have touched off the issue anew. Nobody had heard of Sa'id Budayr until the press appeared on Friday, 14 July 1989, with a brief report about the suicide of the son of artist Sayyid Budayr, saying that he had jumped to his death from the balcony of his third-floor apartment in an old building in one of Alexandria's quarters. Initially, the report did not arouse anybody's interest. But it then became quickly evident that the incident was not a mere

suicide and that the victim was not just the son of Sayyid Budayr, a well-known artist.

The papers in a file carrying the name of the murdered youth and kept in the Egyptian State Awards Department say that Dr. Budayr, an ex-officer of the Egyptian armed forces, was head of the Waves and Pneumatics Research Section of the Egyptian Air Force Technical Research and Development Directorate from January 1983 to July 1987, that he got a Ph.D. in electronic engineering from Kent University, England in May 1981, after he had gotten his M.A. in electrical engineering from the Egyptian Technical Military Academy in July 1976. He was the first to be granted this degree by this academy where he concluded his history of academic excellence in Egypt. He had also gotten a B.S. in engineering with honors in excellence and was on the top of the honor list from the Technical Military Academy in May 1972, in addition to receiving a B.S. in military sciences in the same year. His accomplishments motivated the president of the republic to reward him with the military duty award, second rank, in appreciation of his performance and his devotion to his studies. Budayr's file also notes his international scientific status, even during his regular service in the Egyptian armed forces when, at the age of 35, he was elected a prominent member of the L.E.E.E [probably I.E.E.E., the Institute of Electrical and Electronics Engineers in New York] one of the world's most important scientific electronic engineering organizations, in February 1984 in acknowledgment of his special genius. Perhaps what is most significant in his scientific life is the agreement of officials of the Egyptian armed forces in June 1987 to let him go to Germany to work in his scientific, not military, capacity on Duisburg University's project No. 254 for development of the means to design integrated microwave circuits through the use of computers. Those who were close to Dr. Budayr say that within the context of this project, which cost \$10,000 weekly, he was able to achieve outstanding results in the area of the possibility of communication with all spacecraft and satellites, of gathering (all kinds of espionage information) through such craft, and perhaps even the possibility of jamming them. Even though the project was still in the theoretical research phase, its strategic importance was very obvious. This has motivated some people concerned with the Budayr incident to link the nature of this research with the murder of the Egyptian scientist.

Protection Request

Budayr's private papers, with which AL-MAJALLAH has familiarized itself, include an offer from the NASA, the U.S. space research agency, to work as part of its team. But Budayr did not respond to the offer because, as his wife has told AL-MAJALLAH, the "Americans made it conditional that he get U.S. citizenship to work in this vital sphere." But the man turned down the offer, according to his wife. The papers include a hand-written letter addressed by this ex-officer to the Egyptian military intelligence director. But it seems that death caught up with him before he could send it. (AL-MAJALLAH

has familiarized itself with the receipt of another letter which the Egyptian scientist had sent by insured mail to President Husni Mubarak just three days before his death. None of Budayr's relatives knows the contents of that letter). In his letter to the military intelligence director, Budayr says he lived his first year in Germany, from early August 1987 to the end of July 1988, in the city of Muehlheim without any problems from any circle, until the fruits of his scientific accomplishments began to materialize. He then moved to another house in Duisburg itself—a house located just five minutes from his workplace. Two months after getting into his new home, Budayr says that he "faced some problems and difficulties. I have drawn the attention of the professor with whom I am working to these problems, but the professor has attributed them to excessive imagination and exaggerated sensitivity, or to my wish to find an excuse to break the contract prematurely in order to go to the United States from whence I have received offers for better contracts."

Budayr adds verbatim: "I can list these problems and difficulties as follows:

"(1). I have always felt that I am under observation or surveillance most of the time.

"(2) I have felt that there are individuals who try to provoke or intimidate workers in the places that I frequent.

"(3) My attention has been drawn by a number of incidents that have proven the soundness of my feeling that there is a group or a number of individuals who are working to harm me, either physically or psychologically."

Budayr goes on to add in his lengthy letter that he informed his German professor of his fears which the professor had always attributed to excessive sensitivity, "but his opinion changed in the wake of the latest incident in which a flower box made of plastic and placed on the house balcony was set afire." Consequently, Budayr sent his family back to Egypt as a precaution and agreed with his professor to shorten the duration of the contract (which was to end originally on 31 December 1989) so that it would end on 30 June 1989. But the continued threats, as Budayr says in his letter, motivated him to take the first plane for Egypt, which was on the evening of Friday, 9 June 1989.

In his letter, Budayr refers to a final incident to which he was subjected upon leaving Duesseldorf for Cairo aboard the Egyptian plane on which he had been able to reserve a seat. Even though he did not know the details of the incident (which his wife recounted to us later, quoting her husband), Budayr points out that he believes that the German security authorities were looking for a person who partly resembled him with his thick hair and moustache. He says that this incident proves that he was right in feeling that he had been under observation and surveillance for a long time.

Security Authorities' Interpretation

Budayr notes in his letter that the interpretation offered by the security authorities of the German city of Duisburg is that the mysterious incidents to which he was being subjected were not necessarily the work of Germans and that they could have been staged by Egyptian opposition circles or by radical Arab groups. After rejecting this interpretation, Budayr points out that:

"1) I have no social or nonsocial relations with any German, Arab, or Egyptian in Germany, excluding some contacts with some Egyptian colleagues to inquire after their well-being and to learn their news.

"2) I don't go to any public places and I do not drink or smoke and I consume nothing other than food. I do not leave my house after 1800.

"3) I do not attend any meetings in support of any tendency, sect, or community, not even the Egyptian community.

"4) I have not committed any violation (not even jaywalking) throughout the period I have spent in Germany. Moreover, I have not been interrogated or cited for any illegal act."

Budayr adds in his letter: "Throughout this period of suffering, I did not wish to inform the military attache in Bonn, especially since I had no material evidence to support my fears and suspicions, excluding the fire which broke out on my balcony and which can be easily attributed to a mistake by a neighbor who happened to fling away the butt of a cigarette he had just smoked." He points out that what happened to him upon his return aboard the Air Egypt plane is what motivated him to write the letter which he concludes as follows: "Please be informed and take the necessary steps to:

"1) Verify the true nature of the incident involving the Air Egypt plane which left Duesseldorf for Cairo on the evening of Friday, 9 June 1989.

"2) If it is proven that this incident is true, then please coordinate with the Egyptian and German security authorities to take the steps to investigate what I have encountered and its connection with the latest incident. I am prepared to make any statements and to provide any information on this issue, whether in Egypt or in Germany."

Mystery of Apartment

Jihan Ahmad 'Id, the Egyptian scientist's widow, has recounted to AL-MAJALLAH the mysterious incidents which the scientist encountered throughout the full year of their residence in Germany, saying: "We would wake up in the morning to find objects moved from their places to other places, including photographs on the walls and books. I often heard at night movement in some part of the big apartment. One day I noticed that a big empty box used to pack electrical appliances had been moved from its place atop a closet. When I climbed

a chair to make sure of the fact, I noticed fingerprints in the dust covering the box. After that, we sealed the doors and windows tightly. I also put open books on the door handles so that the books may fall if somebody turned those handles. Despite this, we discovered the same signs, but without any evidence of a door or a window having been opened. We found that nothing was stolen. We put precious items in the way of the mysterious night visitor but he took nothing. What is surprising is that I noticed that this individual made noises intentionally, especially the noises of squeaking doors, to indicate his presence."

Budayr's wife added: "My husband worked at home and all his studies, plus the computer diskettes, were in the house. But we found that nothing was missing. We were subjected to the first incident two months after we moved to the apartment. Contrary to our habit, one day we left the apartment and then returned to find that a book cabinet had been opened and the books scattered. One morning after Sa'id left for his work, I sensed that somebody was standing in front of the bedroom and heard the intruder's footsteps in the hall. But suddenly, I and my son fell back asleep. When I woke up, I found nobody. None of these incidents started until we moved to the new apartment in Duisburg. Sa'id's secretary at the university had advised us to move to this apartment."

AL-MAJALLAH information indicates that the secretary to which Budayr's widow refers is called Klinburg, that she is from Austrian extraction, and that the university put her in charge of the Egyptian scientist's private affairs. Even though it was her job to take him to the airport on the day of his final departure for Egypt and to help him complete all the travel procedures, she used an emergency excuse and left him at the airport's outer gate where, according to his wife, an endeavor was made to obstruct his departure. This is the endeavor to which Budayr referred in his letter to the Egyptian intelligence.

What is the mystery of the Duisburg apartment? What is the story of the secretary from Austrian extraction? What happened on 13 July 1989 in residence No. 20 on Camp Shiraz Street in Alexandria where Budayr spent one night alone (his wife was in Cairo) before he was murdered? Who is Husayn 'Abd-Rabbuh whose name is mentioned in the mysterious piece of paper found in the pocket of the robe Budayr was wearing at the time of his death? Was Budayr murdered, did he commit suicide, or was he forced to commit suicide?

It is premature to reveal the answers to these questions because the investigation of Scientist Sa'id Budayr's death continues and because the outcome of this investigation has not been announced yet. [Box, p 14]

Murdered Scientists

The death of Egyptian Scientist Dr. Sa'id Budayr brings back to mind the long list of Arab scientists who have been murdered by intelligence agencies, especially the

Mosad. The list begins with Dr. Samirah Musa who was murdered in the United States in 1953 and who was specialized in nuclear physics. The same goes for Dr. Samir Najib, an Egyptian nuclear scientist who was murdered in Detroit on 12 August 1967, just one day before he was due to return to Egypt.

INDIA

New Budget Provides for Nuclear Development

51500119A Bombay *THE TIMES OF INDIA*
in English 21 Mar 90 p 7

[Text] New Delhi, 20 Mar (PTI)—A Rs 100 crore cost escalation for the polar satellite launch vehicle project and a Rs 22 crore provision for new heavy water plants, are among the highlights of the 1990-91 expenditure budget for science departments.

The government has also made a provision of Rs 500 crore for new indigenous 235 MW and 500 MW atomic power plants and Rs 16 crore for the Soviet nuclear power plant to be set up at Kudankulam in Tamil Nadu.

The Antarctic research programme, which gets Rs 10 crore, will cover the scientific expeditions to the continent and the establishment of a new Antarctic research centre in Goa.

The cost of the polar satellite launch vehicle, first set at Rs 311 crore when the project was approved in 1982, has now gone up to Rs 414 crore, on account of "inescapable cost escalation and certain uncertainties."

The provision for new heavy water plants this year has gone up to Rs 22 crore from Rs 60 lakh last year. Provisions have also been made for improving works at the existing heavy water plants at Kota, Tuticorin and Baroda.

The Department of Atomic Energy (DAE) expenditure budget also makes a provision of Rs 22 crore for fast breeder test reactor research at the Indira Gandhi centre for atomic research at Kalpakkam.

The DAE's centre for advanced technology in Indore gets Rs 18 crore for infrastructural facilities and new research schemes in laser and accelerator technology for applications in industry and medicine.

The government has also sanctioned nearly Rs 18 crore for two more developmental flights of the Augmented Satellite Launch Vehicle (ASLV) to establish the reliability of its performance. There were two unsuccessful ASLV flights in 1987 and 1988.

A Rs 240 crore project for the development of cryogenic engines, crucial for the indigenous launch of the large geosynchronous satellite launch vehicle, is under critical evaluation.

The Semi-Conductor Complex Limited in Chandigarh which was devastated in a fire last year has been provided Rs 15 crore. But the provision for super conductivity research fell from Rs seven crore last year to Rs six crore this year.

Scientific programmes under the survey of India have been provided Rs 66 crore and will include the establishment of two major computer-aided satellite-based mapping centres.

The assistance to the council for scientific and industrial research has gone up to Rs 235 crore, a Rs 18 crore jump from the provisions made last year.

In the field of electronics, a Rs one crore provision for photonics research is intended to help synergetic development of photonics technology in academic institutions, laboratories and the industry.

A department of electronics (DOE) programme on the development of electronic tools for Indian languages to facilitate human-machine interaction has been allocated Rs two crore.

The DOE provisions also include Rs two crore for the establishment of new courses in selected universities to help generate special manpower for computers.

Meanwhile, the DAE has been allocated Rs 100 crore for an undisclosed project under the head 'other programmes.'

The amount is Rs 30 crore more than the allocation for the entire research and development in the Bhabha Atomic Research Centre.

The budget document does not give any indication of the nature of the project for which the huge amount has been sought.

Government Protests French Nuclear Plant to Pakistan

51500118A Madras *THE HINDU* in English 27 Mar 90 p 9

[Article by K.K. Katyal]

[Text] New Delhi, 26 Mar—India has complained to France about the after-effects of the French President, Mr. Francois Mitterrand's recent visit to Islamabad, especially his decision to supply a nuclear power plant to Pakistan.

Before Mr. Mitterrand went to Pakistan, India had told France of the inappropriate timing of the visit, in view of the intemperate pronouncements from Islamabad. This point was made both in Paris and in New Delhi during the French Prime Minister, Mr. Michel Rocard's visit here. The External Affairs Minister, Mr. I.K. Gujral, told the French Minister of State, Madame Avice, that Mr. Mitterrand's visit, in general, and the plan to supply the nuclear plant, in particular, will have an adverse effect

on Indo-French relations. India felt vindicated by what happened after the visit—a new truculence in the tone of statements by Pakistan Government leaders. Paris was acquainted with these details.

In practice, India had bigger reasons to be sore, because of Mr. Mitterrand's reference to self-determination, in the context of the Kashmir problem. Pakistan lapped up this remark, making full political use of it. According to the French Government's explanation, 'self-determination,' perhaps slipped out and that it should not be construed as support for a call to settle the Kashmir issue through a plebiscite, as mentioned in the UN resolution.

On the nuclear plant issue, however, the French Government stuck to their position—that the decision be seen in

the context of its desire to bolster the fragile democracy in Pakistan, and should not be construed as directed against India. India repeated its objections, drawing attention to other factors like criticism of the French action by the United States and Japan, Pakistan's track record in regard to nuclear matters (the stealth of sensitive material by some of its experts in other countries), and the distinction between the nuclear programmes of Pakistan and India (in the first case, it is military-oriented and clandestine and in the second case, it is open).

It is ironic that the Indo-French relationship should have nose-dived soon after the positive turn, received by it through the Festival of France in India and the untiring efforts of the French mission to convert the new mood into concrete programmes of cooperation.

BELGIUM

Military Shipments to Iraq Under Investigation

Solid Fuel Diversion

90WC0074A Groot-Bijgaarden DE STANDAARD
in Dutch 17 May 90 p 3

[Text] Brussels—Minister of National Defense Guy Coeme said Wednesday that did not receive a report from State Security in which he was warned about the delivery by the Belgian Air Force of military goods originating with PRB, the ammunition firm, which were ultimately destined for Iraq where they would be used to build a supercannon.

Coeme was responding to a question by Francis Vermeiren (PVV) [Party of Liberty and Progress] before the National Defense Committee. Vermeiren said that early this year a C-130 transport aircraft from the 15th Wing of the Air Force was used to deliver solid fuel for self-propelling ammunition. The material in question originated with PRB and was destined for Jordan. But according to recent reports in the British press, it ultimately ended up in Iraq.

Vermeiren pointed out that in 1988 Belgian State Security allegedly warned the British security service MI5 that some arms deliveries to Jordan were apparently ending up in Iraq. Still, only this year the Belgian Government granted a license for the delivery to Jordan and provided logistical support via the Air Force.

Coeme responded that it is not unusual for the Air Force to be used for deliveries from Belgian arms companies to other countries. This occurred, among other times, in 1983 and [year illegible] for flights to Jordan, and also last 6 March for the delivery by the 15th Wing. That flight was approved by National Defense on 27 February after the necessary consent from Foreign Affairs and Economic Affairs was obtained. PRB paid the sum of 2.45 million francs for the flight.

For the contents of the transport, Coeme referred to the Ministry of Foreign Commerce. However, the minister denied every having seen a report from State Security warning against this type of arms delivery.

Supercannon Components

90WC0074B Groot-Bijgaarden DE STANDAARD
in Dutch 18 May 90 p 8

[Text] Brussels—The Brussels public prosecutor's office is conducting an investigation into the role played by the Belgian subsidiary of the West German company Mannesmann-Rexroth in producing components for the Iraqi "supercannon." Components for the "cannon," which was actually supposed to be a type of test bench, were recovered several days ago in Frankfurt.

Similar pipes have already been found in several European countries. The Iraqis maintain that the pipes were intended for a petrochemical project, such as a pipeline.

Belgium became the focus of attention when it turned out to be quite possible that plans for the supercannon were formulated by Gerald Bull, a scientist who was at home in the arms world and who was recently shot and killed in his apartment in Ukkel. Bull's murder has yet to be cleared up. At any rate, the court thinks that it will take a while before the killers are found.

There were more tracks leading to our country. It was discovered that PRB (Poudreries Reunies de Belgique) once sold 210 tons of gunpowder to Jordan. The gunpowder was flown by the Belgian Air Force to Jordan, but ultimately ended up in Iraq. Once the press exposed this, the Brussels public prosecutor's office opened an investigation, and announced yesterday that the investigation has produced results, although it has not yet led to actual suspects.

The day before yesterday, a second investigation was opened after it was revealed that supercannon components found at the airport in Frankfurt were manufactured by Rexroth in Ternat. Rexroth is part of the German Mannesmann Group.

In the meantime, it appears that Italian engineer Aldo Savignano, who works for the Belgian Amalgamated Trading Industries (ATI) headed up the production in Italy of various cannon components over the course of several months. ATI is headed by the Briton Christopher Cowley, a coworker of the murdered Bull.

CANADA

Crack at Darlington Causes 6-Month Completion Delay

51200017A Toronto THE TORONTO STAR in English
5 Apr 90 p A6

[Article by Daniel Girard]

[Text] The cost of Ontario Hydro's problem-plagued Darlington nuclear plant has shot up another \$132 million.

A crack in a 200-tonne shaft in the Unit 2 generator during testing last month has caused six months of delays at the Oshawa area plant, said project manager John McCredie.

The giant utility is forced to pay \$22 million in interest for each month that the plant is out of commission and not producing electricity, he said.

The delay has increased the over-all cost of the plant to at least \$12.63 billion, he said. The estimate when construction began in 1981 was \$7.5 billion, he said.

"These are all estimates. If Units 3 and 4 come on-line earlier (than scheduled) then costs will be reduced by \$22 million a month," he said.

Unit 2, which was expected to be at full power by the end of February, will not be up to 100 percent until 1 July, said McCredie.

The completion date of Unit 1, the second of the plant's four reactors to be in service, will be pushed back to next February, he said.

The cost of the delay is more like \$200 million because of costs other than interest such as workers' salaries, said Energy Probe utility analyst Tom Adams.

This is the seventh cost overrun at Darlington since Hydro estimated it would cost \$2.5 billion when engineering began in 1973, he said.

"This project is clearly out of control," he said.

McCredie, however, said 83 per cent of Darlington delays since site-clearing began in 1978 have been planned because of a smaller than expected demand for electricity.

The \$132 million worth of delays had been factored in when Ontario Hydro chairman Robert Franklin announced a 15.3 per cent increase in 1991 electricity rates last week, said Ian Russell, the utility's director of corporate financial planning and reporting.

AECL Hoping To Sell Second Candu to South Korea

51200016A Ottawa *THE OTTAWA CITIZEN*
in English 10 Apr 90 p A5

[Article by Robert Lee]

[Text] Atomic Energy of Canada Ltd. may be on the verge of its first export in nearly a decade as negotiations intensify in the proposed sale of a second Candu nuclear reactor to South Korea.

The negotiations are under way between AECL and Kepco, Korea's national electricity company, for a second reactor, worth between \$1 billion and \$1.2 billion, at Wolsung.

The first Candu reactor at Wolsung was commissioned in 1983, and has been Kepco's most reliable generator of nuclear power.

In January, Kepco formally called for tenders to build a heavy water reactor. As most nuclear reactors use light water, the specifications are structured so that only the Candu reactor is capable of meeting requirements.

The foundations have already been poured for the second Candu reactor at Wolsung, and AECL has maintained a small sales office in Seoul.

This time, "we're the only ones in the running," said AECL spokesman Michel Hebert. "But that doesn't mean it's in the bag.

"We're hard at work at it," he said. "We hope we can settle by the end of the year."

Hebert said negotiations will revolve around the use of Korean workers, resources, and high-tech components in the project. Kepco expects a higher degree of Korean involvement in this project than the first Candu, reflecting Korea's growth in high-tech manufacturing.

But a highly-placed Korean Government official said price will also be a factor.

"Unless Candu is competitive in terms of price, they will not be likely to get it," said the official, who asked not to be identified.

Candu's last sale was to Romania in 1981. It has also built reactors in Argentina, Pakistan, and India.

Ottawa, Three Provinces To Give AECL Added Funds

51200014A Toronto *THE GLOBE AND MAIL*
in English 31 Mar 90 p A20

[Text] Ottawa—The Federal Government has worked out a plan with three provinces to revitalize Atomic Energy of Canada Ltd., assuring more than \$220-million in annual research financing for the next seven years.

The announcement by Energy Minister Jake Epp yesterday puts to rest speculation about the demise of AECL because of the drought in sales of Candu reactors.

Ontario, Quebec and New Brunswick will all contribute new money to the Crown company and the Federal Government will suspend a planned cut in its contribution.

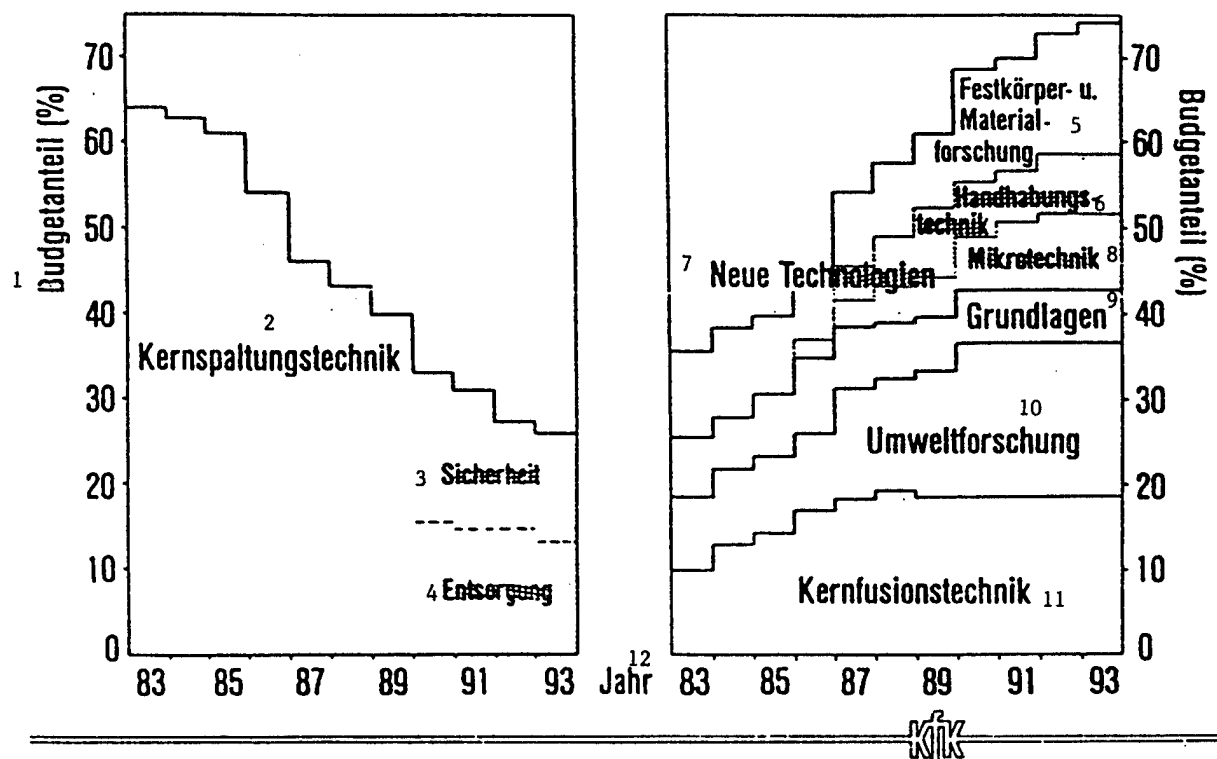
The three provinces now contribute \$45-million each year. In addition, Ontario Hydro will provide \$30-million annually, Quebec \$3-million annually and New Brunswick \$1-million annually for the next seven years. The federal government's contribution will be held at \$144-million this year rather than dropping to \$111-million, as it would have under as 1985 plan.

FEDERAL REPUBLIC OF GERMANY

Karlsruhe Nuclear Research Center's 1990 Budget Published

90MI0167A Bonn *TECHNOLOGIE NACHRICHTEN-MANAGEMENT INFORMATIONEN* in German
No. 521, 19 Feb 90 pp 10-11

[Text] The Karlsruhe Nuclear Research Center (KfK) has recently presented its 1990 program budget, setting out its new medium-term project and finance plans for the years 1989 through 1992. Its range of promising



Key: 1. Budget share (percentage)—2. Nuclear fission technology—3. Safety—4. Waste disposal—5. Solid-state and materials research—6. Handling technology—7. New technologies—8. Microcircuitry—9. Basic research—10. Environmental research—11. Nuclear fusion technology—12. Year—

major research areas such as the environment, materials, nuclear fusion technology, micromanufacturing, and handling technology will be extended, whereas nuclear technology research and development work will concentrate exclusively on safety and waste disposal, which are priority research policy areas.

The Karlsruhe Nuclear Research Center remains the main channel for the FRG's international commitments in this area. It not only coordinates cooperation with East Bloc countries, but is also a direct partner in contracts with the USSR and the GDR. It is also involved in intensive cooperation contracts with American, Japanese, and Korean research centers, and is a major partner with the UK, France, Belgium, and the Netherlands.

The Nuclear Research Center currently has an overall budget of approximately DM730 million. This also includes transmitted amounts for contributions, such as the Laue-Langevin Institute in Grenoble, project management, and special financing totaling DM84 million. When the center's own earnings of approximately DM130 million are deducted, state funding for the KfK amounts to DM600 million.

The following diagrams show how the KfK's priority areas are evolving:

The Karlsruhe Nuclear Research Center program budget can be obtained from the Karlsruhe Nuclear Research Center GmbH, Public Relations Department, P.O. Box 36 40, 7500 Karlsruhe 1, Tel: 07247/822861.

Advances in Neutron Spectrometry Announced

90WP0043A Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 2 Feb 90 p 8

[Text] Frankfurt, 1 Feb—Neutrons are becoming increasingly important in the structure elucidation of solids and crystals. They are not as readily available as X-rays, infrared light or even nuclear magnetic investigative techniques. That is to say, neutrons can only be produced in specially constructed nuclear reactors or by means of high energy proton beams which, on impact with a series of heavy metals such as bismuth, lead, tungsten or uranium, smash the atomic nuclei and liberate the neutrons which exist in these nuclei. Such facilities are referred to as "neutron spallation sources."

For the development of new materials, scientists need better methods of structural analysis and, therefore, can no longer forgo investigations using neutrons. It has been little more than two years ago that the financing of a so-called neutron spallation source at the Juelich nuclear research establishment was denied, after heated debate, by the Federal Ministry for Research and Technology in Bonn. The reason given at the time was: sufficiently productive neutron sources were available to German materials researchers in the European Community, most especially in Great Britain. It was a short-sighted decision because, meanwhile, all research laboratories have become fully booked. Only the most important neutron investigations can still be considered.

Neutron spectroscopy is in high season. Nearly every European research institute equipped with a neutron source is committed for weeks and months. There are waiting lists and the institute administrations have great difficulties evaluating the submitted neutron experiments in order to set even halfway fair priorities. This crush is produced by the European materials researchers who can no longer make do with the hitherto conventional investigative techniques such as X-rays, infrared light or magnetic nuclear spin studies in order to produce new types of materials. This is true for high molecular weight polymers as well as for new types of ceramics, for example high-temperature superconductors. Only if European enterprises are at least partly able to keep up with their Japanese and North American competitors for new materials, will Europe maintain its industrial position in the coming decades: new materials are the key to further technological advancement.

Nevertheless, the "neutron bottleneck" can be overcome: that is to say, the Wuerzburg physicists, Reinhart Geick and Holger Tietze have discovered an improvement in neutron spectroscopy which is currently being developed to the implementation stage through a joint effort with researchers of the British Rutherford Appleton Laboratory in Abingdon near Oxford. They call their new spectrometer "Rotax." This is an abbreviation for "Rotating Crystal Analyzer Spectrometer."

Rotax is able to use the neutrons employed in neutron diffraction investigations considerably more effectively than before. This is accomplished through highly precise and lightning-fast rotatory movements of the reflecting neutron mirror used in the experiment. Movements which, in their precision and speed, widely surpass those actuators which are currently used in robotics.

Thereby, it will be possible to precisely adapt the neutron mirror to the neutron pulses of the British neutron spallation source. This way, at most only ten percent of the neutron beam is lost. And this leads to the result that diffraction studies, compared with techniques used to date, require less time and thus are also less costly. One can handle the inherently "costly" neutrons considerably more economically in the future. By introducing Rotax, the British institute can therefore accommodate a considerable number of additional experiments.

The Bonn Ministry for Research and Technology recognized very rapidly that thereby one may counter, at least in part, the frequent complaints of material researchers about lacking research capacities. The development of Rotax is supported with three million DM from the research budget. For that, because of the close German-British cooperation, the Wuerzburg group will be granted a place on the British neutron source. Later, the running costs will also be divided fifty-fifty between them. In the future, about half of the assignable experiment time at Abingdon will be made available to German investigators without restrictions.

Nevertheless, it is now found that the 1987 decision to install no new, modern neutron source at the Juelich nuclear research facility was certainly in error. The bottlenecks which arose since then could have been avoided and the German materials researchers would be in a better starting position today, for example, with respect to new types of polymers and high-temperature superconductors.

At this time, Rotax is applied exclusively to the spallation neutron source at the Rutherford Appleton Laboratory: it delivers neutron pulses at millisecond intervals. They impinge on the sample material to be studied and are then altered according to the sample's structure. The diffracted neutrons are then reflected from a movable, single-crystal analyzer to a group of neutron detectors. Since the pulse frequency of the neutrons is precisely known, it was relatively simple also to determine the necessary movements of the analyzer as a "neutron mirror."

Through the sample material, the neutron beam undergoes changes in its velocity and intensity depending on which atoms in the sample it strikes. If the neutrons do not undergo any velocity change, then the structure of the sample can be determined. If, on the other hand, there is a change in neutron velocity, then the neutrons exchanged energy with the sample. From this, one may infer the exchanged excitation energies. For example, if the crystal lattice is set into vibration, then the extent of measurable photons provides a measure for the determination of such energies. They are known, according to the rules of quantum physics, to occur only at clearly distinguishable "energy levels."

Neutron spectroscopy is so very important also in the structure determination of new types of chemical compounds because it pinpoints the position particularly of the lighter chemical elements in a compound. It involves, for example, hydrogen and oxygen atoms which play a large role in organic compounds. The type of the chemical bond between different atoms can be precisely determined with neutrons. This can be done with inorganic as well as with complicated organic compounds. Using neutrons, polymer layers only a few nanometers thin can be measured. And finally, the structures of magnetically active alloys and compounds can be determined.

For example it was determined by neutron analysis of new, high-temperature superconductors the decisive role that

oxygen atoms play in these ceramic compounds. Although physicists are still debating how superconductivity is achieved in the so-called Zurich-Oxides, it is today nearly certain that high-temperature superconductivity depends on structure in the single-crystalline domain. Since the structures of crystal lattices can be altered, it can be foreseen that in the near future it will become possible to bring high-temperature superconductors with high critical currents into technical use. This holds true also for other materials such as high temperature ceramics or for protein-like synthetic materials with high durability, solidity and temperature stability.

FRANCE

Superphenix Reactor Functioning Again

90WP0075A Paris *LIBERATION* in French 16 Apr 90 p 8

[Text] The core of the Superphenix has been reactivated. The Creys-Malville (Isere) breeder, which has been shut down for the past seven months, began functioning again Saturday night. In the evening, the 1,300-MGW reactor had received the green light from the safety authorities.

The fast neutron reactor—which had been joined to the EDF in April 1989 after a lull of one and a half years as a result of the famous barrel chamber incident—had again been idle since last 7 September. Before authorizing its reactivation, the Central Safety Service for Nuclear Installations (SCSIN) had asked the technicians to prove that last October's incident, caused by an argon bubble on the small (300 MGW) Marcoule (Gard) Phenix breeder, could not be reproduced on the Superphenix. Let us recall that this argon bubble could have caused a disequilibrium in the functioning of the reactor's core which, it is feared, could still malfunction. According to SCSIN Director Michel Laverie, who gave his approval for the reactivation, the Superphenix configuration differs from that of the Phenix and "we cannot see how an argon bubble could be produced."

On Saturday night, the Council of State of the Geneva Canton protested loudly when it learned about the French authorities' decision to proceed with the reactivation without waiting for the judgment of the Grenoble Administrative Court which is scheduled to mediate next June. In fact, six Swiss communes had referred the matter to the French court which had ordered an experts' report in mid-March.

IRELAND

Minister Introduces Radiological Protection Bill

51500120A Dublin *IRISH INDEPENDENT* in English 30 Mar 90 p 5

[Article by John Foley]

[Text] Fines of up to 1m and life imprisonment are provided for in a new government Bill designed to crack down on possible terrorist nuclear attacks.

Individuals and corporations are also liable for similar penalties for offences, under the Radiological Protection Bill published yesterday by Minister for Energy Bobby Molloy.

Lesser fines of up to 1,000 have been set for summary conviction for stealing any substance or device, and 100,000 for similar offences with an international dimension.

The Bill abolishes the Nuclear Energy Board and sets up a Radiological Protection Institute of Ireland to monitor radioactivity and advise the government on radiation safety levels.

It will also have a key role in advising the government on responses to nuclear emergency, setting guidelines for handling and controlling radioactive materials, and in research.

When passed into law, the Bill will enable the government to ratify a number of international conventions developed since the Chernobyl nuclear disaster in 1986.

But its main objective is to have the Institute monitor radiation levels and take action to protect public health when international levels in food are exceeded.

The Bill sets out steps to be taken by the Ministers for Agriculture, the Marine and Finance to protect the public from contaminated food, fish, and wildlife.

It also replaces the Nuclear Energy Board which was set up in 1971 and which was condemned for its performance in the wake of the Chernobyl explosion.

The Bill, due in the Dail after Easter, was strongly criticised last night by Fine Gael's Energy spokesman, Richard Bruton, who questioned any role for the Minister for Energy.

The independence of the new Institute was undermined by, what Mr. Bruton termed, the "overbearing power" given to the Minister to intervene in its affairs.

Fine Gael's view was that the functions of protecting the public, in a nuclear disaster situation, should properly be vested in an Environment Protection Agency, he said.

ITALY

X-Ray Facilities for Synchrotron Set for 1994

90MI0094A Milan *ITALIA OGGI* in Italian 7 Dec 89 p 37

[Article by Daniele Bo: "Ansaldo Wins Bid for Grenoble Synchrotron"]

[Text] Ansaldo, together with the French Bouygues and German Strabag groups, will design and construct a large part of the structure and buildings (about 80 percent) of the European Synchrotron Light Laboratory (ESRF) in Grenoble.

The order was made following a call for bids which involved twelve multinational consortia. The value of the order is approximately 80 billion lire, about half of which should go to the Italian group which will work on the strictly technological aspects. In terms of value, this will constitute approximately 20 percent of the investment costs for the entire project. The goal of the ESRF, which is financed by eleven European countries, is the development of a 6GeV electron accelerator ring to be used as a source of synchrotron light in the area of X-rays, starting from 1994.

The facility will be used by scientists from countries involved in basic and applied research in sectors such as the science of materials and surfaces, crystallography, physics, earth sciences, biology, and medicine.

In January, construction will begin on the buildings that will house the accelerator, the electron accumulation ring, the circular experimental "hall" with a circumference of almost one kilometer, and some auxiliary technical equipment. Work should be completed in the fall of 1991.

In the meantime, work is proceeding on the components of the accelerators. Forty percent has already been contracted out to various European firms.

It is expected that the first synchrotron radiation will be produced by the end of 1992.

NORWAY

Foreign Ministry Tracking 440 Tons Heavy Water

90WP0085A Oslo AFTENPOSTEN in Norwegian
30 Apr 90 p 6

[Article by NTB [Norwegian Wire Service]: "New Concern Over Heavy Water in Foreign Ministry"]

[Text] As State Secretary Knut Vollebaek reports, the political leadership in the Foreign Ministry does not have a detailed survey of where Norwegian heavy water exports have been going.

Approximately 440 tons of heavy water produced in Norway have presumably been exported in the period since the war until Norsk Hydro discontinued production in 1989.

Again, there is concern that the Norwegian heavy water could have been used for the manufacture of nuclear weapons. The new regime in Romania is said to have confirmed that 12.5 tons of Norwegian heavy water were sold from Romania to India in 1986. Foreign Minister Bondevik has warned that Norwegian authorities would pursue this matter very seriously. He feels a clarification that the heavy water is used only for peaceful purposes would be in the interest of both Norway and India.

However, Norway has no formal right to demand an inspection or the return of the heavy water from India.

There are therefore great doubts about what can be achieved. And a previous instance does not exactly encourage optimism.

In 1988, a police investigation was started because 15 tons of Norwegian heavy water which were intended for legal export to West Germany most likely ended up in India. The delivery was made in 1983. Neither investigations nor political pressure have apparently yielded any success, two years after the matter was brought up.

Small Victory

The political leadership in the Foreign Ministry, however, counts the heavy water issue involving Israel as a small victory. In the fifties and sixties, Norway exported 21 tons of heavy water to Israel based on guarantees that it would be used for peaceful purposes. A lack of inspection caused political concern in Norway. A short while ago it was agreed that Norway would get back half of the heavy water.

SPAIN

CSN Report on Vandellos I Discussed

90WP0080A Madrid DIARIO 16 in Spanish 8 Apr 90 p 10

[Text] Madrid—The Nuclear Safety Council (CSN) yesterday made public the final report on the Vandellos I nuclear power plant in Tarragona. In it it sets forth a series of safety requirements that the operating company, HIFRENSA, must meet before any start-up of the plant.

The measures would cost some 40 billion pesetas and would take at least four years to implement. This means that starting up the plant could be financially impractical, although the decision ultimately depends on HIFRENSA, the operating company.

In order to insure safe operations at Vandellos I HIFRENSA must make the modifications that the CSN demanded in 1986 and that were not carried out; it must also meet new safety requirements that include further studies, site analyses, and improvements in plant organization and equipment.

Modifications Not Made

The three-part report first offers an analysis of the accident. According to the CSN, the consequences of the incident on 19 October of last year are directly related to the failure to make two of the five major modifications demanded of the power plant after the Chernobyl nuclear accident in the Soviet Union in 1986 (having to do with fire safeguards and the cooling system), plus the failure to comply with other requirements relating to various aspects of the Safety Reassessment Program.

The final CSN report indicates that the incident at the Tarragona power plant was a level-three accident on the international scale for evaluating the gravity of nuclear power plant incidents; this is described as a "serious incident."

It adds that the incident was significant from a safety standpoint, emphasizing, however, that neither areas nor individuals were ever contaminated, nor were there radiation releases greater than the normal operation of the plant entails.

The second section of the report analyzes overall safety at the plant and orders HIFRENSA to submit a thoroughly detailed safety plan for the entire system, specifying the deadlines for completing it, the company that will perform the work, and the methods that it will employ.

The final section of the CSN report sets forth the specific measures that are required for the plant reactor to start up again.

In light of yesterday's report, HIFRENSA will have to do several things before resuming operations at Vandellos I. They include the classification of safety structures, systems, and components and the modifications needed to safeguard against earthquakes, internal flooding, pipe ruptures, and adverse weather conditions.

Moreover, HIFRENSA must also have measuring devices available to conduct mechanical, nuclear, and heat-flow analyses of the reactor and must review the structural design of the containment shell, the last line of defense.

Other safety measures that the CSN is demanding of the electronics group that owns Vandellos I in order for it to resume operations include improvements in the reactor cooling system and the guaranteed habitability of the control room.

Emergency Plans

Furthermore, the CSN report calls for the review of emergency plans, a comprehensive analysis of reactor control and safeguard systems, the installation of additional emergency sources (diesel generators) to insure a supply of electricity, and improvements in radiological safeguards.

In conclusion, the report urges a study of the plant site, an analysis of its impact on the plant, a reassessment of the accidents cited in the safety report, and probability analyses of safety.

The CSN must verify that all of the safety demands have been met before Vandellos I can start up again.

The report also recalls that the French power plants Chinon I and II and Saint Laurent des Eaux I and II, which were used as a reference point for Vandellos II, have begun to be dismantled and will be closed before 1994.

UNITED KINGDOM

Region Given All-Clear From Chernobyl Radiation Effects

51500110A Leeds *YORKSHIRE POST* in English
7 Apr 90 p 2

[Article: "Region Given All-Clear After Radiation Tests"]

[Text] Pollution experts yesterday carried out the first full-scale tests on radiation levels in Yorkshire and Humberside since the Chernobyl nuclear disaster of four years ago.

Monitoring on 20 different sites showed that hot spots detected after the nuclear accident in the Soviet Union had now disappeared, and the area was well below recommended contamination levels.

It is believed that the tests were the first of their kind in the country to be carried out on such a wide area.

Local authorities throughout the region installed sophisticated detection equipment after Chernobyl, and yesterday the levels of radiation in 20 towns were taken at exactly the same time.

The results showed that the highest level was one fifth of the recommended maximum exposure to radiation in a year.

One of the safest areas was the Craven district, which after Chernobyl displayed worrying signs of hot-spot radiation levels.

The survey was carried out by the Yorkshire and Humberside Pollution Advisory Council to mark today's World Health Day.

The council secretary, Mr. Bob Crosby, said: "The important part of the survey showed that we can monitor pollution levels across the region, which we could not do immediately after Chernobyl.

"We are delighted with the results, which show Yorkshire and Humberside to have very safe levels of radiation exposure.

"It was particularly pleasing to note that the hot spot areas in Craven have now disappeared."

The council intends to carry out more tests on a regular basis.

Government Nuclear Waste Disposal Policy Scored

51500109A London *THE DAILY TELEGRAPH*
in English 17 Apr 90 p 8

[Article by Christine McGourty: "High-Level N-Waste Policy Under Fire"]

[Text] Friends of the Earth [FoE] accused the government today of having no coherent policy for disposing of high-level radioactive waste. It criticised the lack of a

timetable for deciding how to dispose of this waste, lack of research into what type of rock would be suitable and lack of investigations into potential sites.

In a survey of the waste-disposal policies of 13 countries, carried out for FoE by an independent geologist, Mr. Phil Richardson, Britain was the only country with no plans on any of these three issues.

Friends of the Earth spokesman on energy, Mr. Michael Harper, said yesterday: "The U.K. has no specific plans for dealing with this exceptionally dangerous waste form, but still continues to produce and accumulate it. This shows irresponsible indifference."

He also criticised the lack of an independent body to oversee disposal of high-level waste. Nirex, the nuclear waste disposal company, has responsibility only for low- and intermediate-level waste.

Responsibility for high-level waste, which comes from spent fuel rods or liquid waste from reprocessing this fuel, lies with British Nuclear Fuels Ltd. At present, this waste is stored in stainless steel tanks at Sellafield, but BNF plans to store all 4,000 tonnes in glass blocks.

The radioactive liquid and molten glass are poured together into stainless steel containers where they will be stored for up to 50 years. FoE is calling for a halt to production of this waste and increased efforts towards a long-term solution.

None of the other countries surveyed—Belgium, Canada, Finland, France, Italy, Japan, Spain, Sweden, Switzerland, the United States and West Germany—has decided how to dispose of the waste permanently. However, almost all have drawn up timetables for decision-making, and are researching sites for long-term storage.

A spokesman for the Department of the Environment could not comment on the report.

Home Office Adds to Report on Nuclear Dangers in Space

51500108A London THE DAILY TELEGRAPH
in English 21 Apr 90 p 14

[Article by Roger Highfield: "Nuclear Risk From Space Junk"]

[Text] A collision between a nuclear-powered satellite and space junk could lead to "global scale contamination" with nuclear fuel particles and radioactive fission products, according to an international report.

The Paris-based OECD Nuclear Energy Agency and the Swedish National Institute of Radiation Protection say in a report on emergency preparedness for nuclear satellites that the rapidly increasing amount of man-made space debris could "soon present serious problems in connection with the use of nuclear-powered satellites."

The European Space Agency showed the risk of a collision "is not negligible. With 30 reactor cores the probability of a collision within the next 10 years is around one percent. With increasing debris the collision probability will rapidly increase," says the report.

The main hazard in a collision between one of an estimated three million kilograms of junk now in orbit arises from the release of fission products produced by burnt nuclear fuel.

In a collision between an operating or newly shut-down nuclear powered satellite and space junk, millions of collision fragments may be generated. "If the uranium particles are not vaporised during the re-entry phase (indicated by theoretical studies), a global-scale contamination with nuclear fuel particles and fission products could be the result."

However, the report does not spell out the risks posed by this global contamination. It focuses on the dangers of a nuclear-powered satellite falling to Earth.

It could scatter debris over an area of 1,200 miles by 200 miles with possibly no accurate warning of impact, according to British emergency guidelines contained in an annex.

The likelihood of an accident is remote, says the Home Office. But it points out that it is difficult to make firm assumptions about the features of a satellite accident, with forecasts of the precise point of impact of a stricken satellite being within a "range of thousands of kilometres."

The OECD expert group that compiled the report recommends that countries be prepared for the accidental reentry of nuclear-powered satellites which can scatter radioactive items "ranging from large pieces to particles in the sub-millimetre size."

Home Office guidelines say that since much of the debris could be very small, "unnoticed irradiated debris might be scattered over an area of thousands of square kilometres. A major search operation might have to be mounted."

Until the beginning of 1989, on at least six occasions, nuclear-powered satellites have malfunctioned. Releases of radioactivity occurred on three occasions.

The main hazard comes if individuals pick up and retain highly radioactive debris. The chance of this happening is "not at all negligible," the report said, pointing out that on reentry some 20 pieces out of an estimated 500 of the U.S. Skylab space station had been found and about 10 large pieces of the Soviet nuclear satellite Cosmos 954.

The simplest radioactive power sources are thermoelectric generators, which use the heat of radioactive decay to produce electricity. Actual nuclear reactors in spacecraft have mostly been used by the Soviet Union in its

Cosmos satellites. Until now more than 30 nuclear-powered satellites have been launched, carrying more than 1,000 kg of uranium.

M16 Assessment of Iraq's Nuclear Efforts Reported

51500111A London THE SUNDAY TELEGRAPH
in English 1 Apr 90 p 13

[Article: "The Undercover Nuclear War"]

[Text] Christopher Dobson and Simon O'Dwyer-Russell tour the hidden battlefield in the struggle to obtain the world's deadliest weapons—and the nations queueing to join the new arms race.

The Krytron "sting", in which American and British Customs stopped nuclear triggers reaching Iraq, is the latest stroke of a deadly struggle between the haves and have-nots of the nuclear world.

Countries like Iraq with its ambitions for overlordship in the Middle East, will go to almost any length to acquire the equipment to produce nuclear weapons. Israel, defending its nuclear lead in the region, will go to similar lengths to stop them.

It is a struggle which has led to a string of murders around the world as undercover hit men, working for governments determined to keep their foothold in the nuclear race, have eliminated rivals. A struggle which, even before last week's sting and before the handing of the Iranian journalist Farzad Bazoft in Baghdad for "spying", had already focused the West's anxieties on the regime of President Saddam Hussein.

Three years ago, the Iraqi Army was on its knees, struggling to hold the city of Basra against endless human-wave-attacks by adolescent Iranian Revolutionary Guards. It was the height of the Gulf War.

A secret assessment of the Middle East, drawn up by M16 and circulated to senior officials and ministers in Whitehall, painted a chilling picture of how the war might end.

Intelligence officers said that Hussein had ordered an all-out push by scientists to develop nuclear weapons, an objective crippled when Israeli aircraft destroyed Iraq's only nuclear plant at Osiraq in 1981.

M16 assessed that if Saddam Hussein obtained a nuclear weapon, it would be used on an Iranian city in a desperate attempt by the Iraqi leader to end the Gulf War with "grand-slam" reminiscent of Hiroshima and Nagasaki.

The prospect of Iraq becoming a nuclear power was taken seriously by the Government. M16 was ordered to step-up its efforts with Israel's secret service, Mossad, and America's CIA, to thwart Iraqi attempts to steal or buy nuclear secrets.

M16's doomsday theory was at the time all too realistic.

With the bloody war going badly and Iraq's highly-mechanised Army overwhelmed by the number of young Iranian zealots, Hussein had already resorted to the use of chemical weapons, begun the indiscriminate bombing of oil tankers in the Persian Gulf and ordered saturation missile attacks on Iran's cities.

"We felt that the next step for Iraq was for Hussein to acquire a tactical nuclear weapon—not for deterrence, but for use against Iran—and quickly", one Whitehall source said last week.

A few months before the siege of Basra, Israel warned London that Colonel Gadaffi of Libya had supplied both Syria and Iran with SCUD-B missile warheads filled with nerve gases.

The fragile balance of power in the Middle East, maintained largely through Israeli military might, seemed as though it might topple at any moment.

The fact that, three years on, Iraq is still without the means to fulfill its horrifying ambitions is a tribute to the efforts of the United States, Israel, and Britain to counteract Baghdad's persistent efforts to beg, steal, or borrow nuclear technology. It has been a murky business, the cost of which rarely emerges.

Lives are cheap when the stakes are so high. The murder in Brussels 10 days ago of Dr. Gerald Bull, scientist, weapons expert, and arms dealer, is a case in point. Dr. Bull was professionally killed with two shots to the back of the neck. Theories as to why are rife.

One is that he was on the Iraqi Government's payroll and was due to check that the 40 krytron triggers were genuine. Thus, he could have blown the whistle on the elaborate trap being sprung on the Iraqis by United States and British security.

Bull's history runs like a hidden thread through the world of underground arms dealing. He worked for the American and Canadian Defence establishments and in the 1960's became head of HARP, the U.S. Army's High Altitude Research Project which used smooth bore Naval guns to fire experimental projectiles to heights of nearly 200 kilometres—the edge of space.

He later set up his own company, the Space Research Corporation of Quebec, and carried on his HARP work, specialising in developing long range shells and a 155 millimetre Howitzer to fire them.

They were precisely what South Africa needed to counter the Russian 122 millimetre guns the Cubans used against South Africa in Angola.

Bull was forbidden under the U.S. anti-apartheid arms embargo to export either his guns or his shells to South Africa. He got around this by helping the South African ARMSCOR to develop its own the gun and by making illegal shipments of the shells.

He sent them for "testing" to Antigua in the West Indies, where they were the covertly transhipped to South Africa. The FBI heard of this and Bull spent three months in prison. When he came out, he set up SRC again—in Brussels, outside the FBI's jurisdiction.

Meanwhile, South Africa had developed his gun into the brilliant G5 and motorised G6 Howitzer, reported to be one of the best artillery pieces in the world. It can fire a 155 millimetre shell 32 miles with great accuracy. It is also believed—and this is the significant point in the Bull saga—to be able to fire a nuclear shell.

From this time, Dr. Bull's connections with Iraq began to harden. That country bought at least 100 of these weapons and used them with telling effect during the Gulf War.

That alone would make Bull a marked man in Iranian eyes; but it is possible that others might have had even more telling reasons for killing him. The Israelis to preserve their nuclear lead? Western intelligence to protect its krytron operation against Iraq? Enemies in the arms trade who accused him of double dealing?

Whoever did it was a professional. The money in his wallet was untouched. Nothing was taken from his apartment—he was killed for who he was and what he knew.

Another expert to die violently in mysterious circumstances was Yahia El Meshad, Egyptian born head of Iraq's Atomic Energy Agency, bludgeoned to death in his bedroom at the hotel Meridien, near the Arc de Triomphe in Paris. In a grisly forewarning of Dr. Bull's murder a decade later, El Meshad's wallet, containing 150 pounds sterling, was untouched. So were his personal documents. His killer left a "Do Not Disturb" sign on the bedroom door.

El Meshad was killed in 1980, one year after an Israeli saboteur team broke into a warehouse in Toulon where the "beehive" cores of two nuclear reactors supplied by France and destined for Iraq were stored. Mossad agents tried to steal them, ran out of time and blew them up instead.

Both cores were heavily damaged and it was thought that the raid would severely delay Iraq's nuclear plans.

French police kept the murder secret for four days to give the French Foreign Ministry time to reassure the Iraqis that French intelligence had not been involved.

Suspicion immediately fell on the Israelis and, although they never admitted responsibility, they also never disguised their satisfaction.

In its report of the murder, Israeli Radio declared: "El Meshad was one of a small circle of Arab physicists with

advanced atomic know-how. Iraq's plans to obtain the atom bomb have been set back two years by this murder."

It did not stop the Iraqis. In the Spring of 1981, Israeli intelligence reported that the Osiraq Research Reactor just outside Baghdad would be completed by the end of the year. On June 7, 1981, the Israeli Air Force went into action. Eight F16 bombers each armed with two 1,000 kilogram bombs took off with an escort of six F15 Eagles to attack the Osiraq Reactor.

They made just one pass over the building and despite its heavy concrete reinforcement it was totally destroyed.

So complete was its destruction that rumours immediately began to circulate that French technicians had planted bombs inside the premises, possibly building them into the fabric, to be exploded simultaneously with the air attack in order to ensure the reactor's destruction.

The people who believe the story point to the ease with which the sabotage team penetrated the Toulon warehouse, and the murder of El Meshad in Paris as evidence of French complicity.

The reasoning behind this accusation was that France did not want Iraq to become a nuclear power but had no intention of endangering its oil supplies, or the lucrative arms sales it was making to Iraq, and so it connived with Israel instead of breaking its deal with Saddam Hussein.

During the oil crisis which followed the 1973 war in the Middle East, France and Italy had come to an agreement with President Hussein to open the doors of the nuclear club to Iraq in exchange for a guaranteed supply of oil.

France played the leading role, and in 1975 Hussein flew to Paris to sign a deal under which France would build Iraq two reactors and supply 75 kilograms of uranium.

Prime Minister Jacques Chirac himself showed President Hussein round the French nuclear centre at Cadarache. Afterwards they celebrated the deal at one of France's most celebrated restaurants, Le Baux de Provence, with a lunch of red mullet and stuffed pigeon.

The deal was approved by the International Atomic Agency, but what the French neglected to tell the agency was that the uranium they had supplied had been enriched to 93 per cent. Given the necessary equipment it is relatively simple for a competent nuclear scientist to increase this ratio to 97 percent and thereby obtain weapon grade fuel.

The Israelis watched with growing apprehension as it became clear the Iraqis were determined to produce nuclear weapons. Then, in 1979, they struck and triggered off the long sequence of violence which persists to this day.